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Power Without Labor

PHYSICAL LABOR ELIMINATED AND THINKING THE MAIN OCCUPATION AT THE ALTON, GRANITE CITY AND ST. LOUIS POWER STATION

IT IS DIFFICULT to predict where the growth of the use of power is to end, if at all. In the city of Alton, the power used has stood at something like 1500 kw. maximum demand for a long term of years, and suddenly there comes a steel works which calls for 3000 kw. and growth of general demand of some 1000 kw., which necessitates quadrupling the station capacity. And on top of that is a call for current for the interurban railway running to St. Louis, in addition to the current needed for the street cars of the city of Alton. A new station was the only possible answer to this problem, and it has accordingly been built.

For the temporary supply, the hydroelectric power from Keokuk was called into service, and provisions were made at Alton to step down the voltage from 66,000, at which it was received from Keokuk, to 13,200, at which it is sent on to East St. Louis, for supplying the lights, cars and mills of that city; for the whole system is interlinked, and the same management is in control of the East St. Louis Light and Power Co., the East St. Louis and Suburban Railway Co., which runs the lines to Edwardsville and the street cars of Edwardsville, the Alton, Granite City and St. Louis Traction Co., which operates the line from St. Louis to Alton, and the Alton Gas and Electric Co., which handles the local supply for that city.

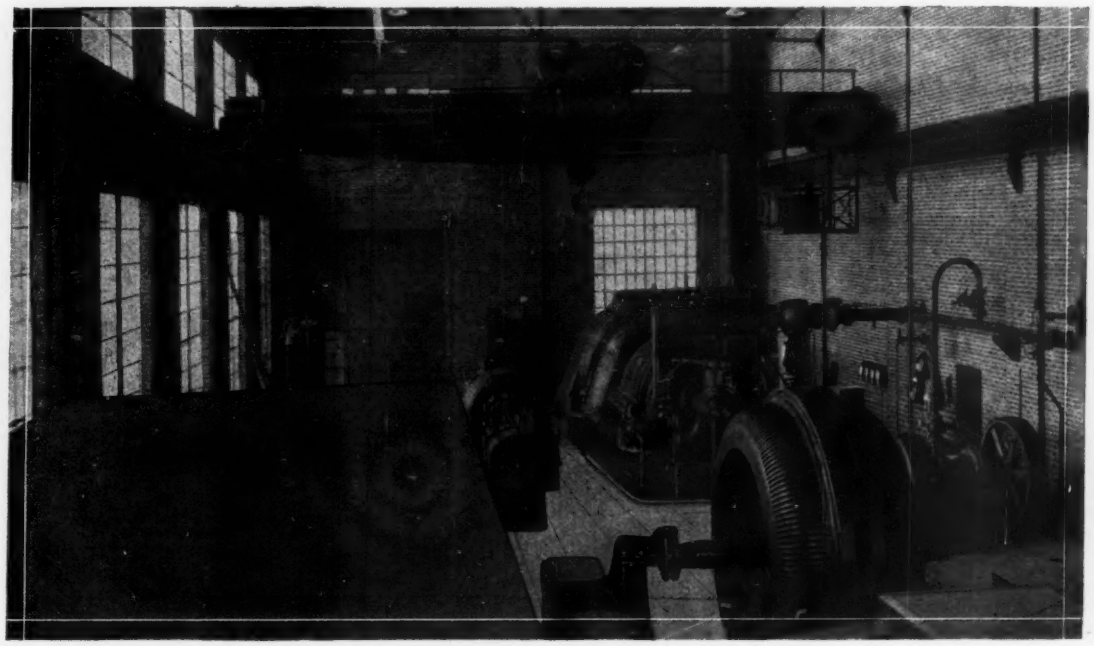


FIG. 1. ONE END OF THE TURBINE ROOM

It was not necessary to provide spare equipment for the Alton station, for it will run in parallel with the Keokuk power, the latter source taking up large swings in the load and being ready to pick up at any time that the Alton plant might shut down for any reason; but the new plant is planned to carry the bulk of the load at all times. Eventually, it is planned to send the current to East St. Louis at 66,000 volts, as the distance is 26 miles, rather too long a distance for profitable transmission at 13,200 volts.

In Alton, constant current of 10 amp. will be supplied for street lighting, current at 2300 volts for commercial business and stepped down as may be needed, and 550-volt current for street cars. The current will be generated by the turbine at 13,200 volts and stepped up to 66,000 volts for the long distance line, and converted by frequency-changing motor generators, and by transformers and rotary converters and tub transformers for the local service.

main building is in 2 rooms, with a fire wall between. In one of these are the turbine and its auxiliaries and the electrical machinery and apparatus, and in the other boilers, economizers, pumps, stokers and other apparatus which has to do with steam generation. In the turbine room a Case crane spans the room, the track being carried on the walls, and the roof is supported by steel trusses and purlins covered with Ferroinclave arches with concrete gutters, steel lined, and with J-M 3-ply roofing for the final covering. Both turbine and boiler room sections are surmounted with turrets for light and ventilation, and have concrete floors on steel beams with gratings over where it is desirable to have ventilation. The turbine room is 112 ft. 6 in. by 42 ft., with 32-ft. walls, and the boiler room is the same height, with width of 57 ft. 8 in. and length of 96 ft. 6 in.

Separated from the main station by an alley is the substation, which is of concrete with brick veneer and with roof of the same construction as the main station.

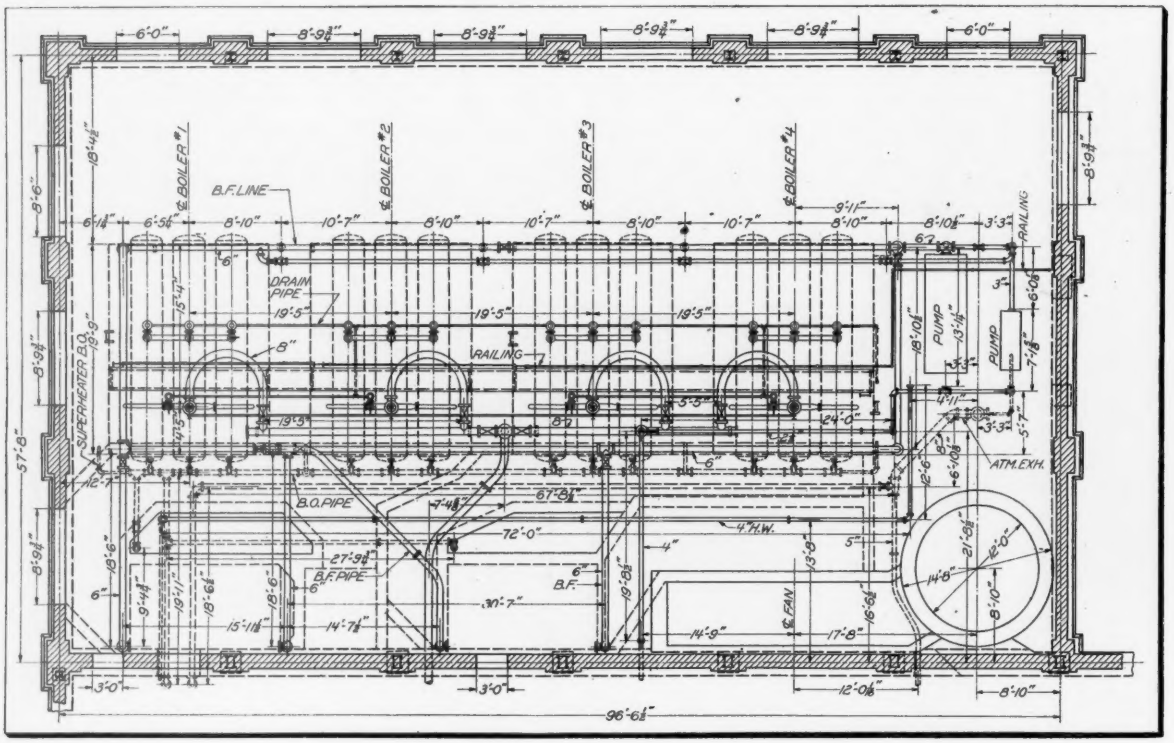


FIG. 2. PLAN OF BOILER ROOM AND ITS PIPING

The plant is located on the shore of the river, about ½ mi. above the business section of the city, on a level spot that has been formed by the quarrying of the rock from the bluff. It is of red brick, with steel frames for the windows and concrete sills. The doors are rolling steel shutters, and the small, individual doors of steel in steel frames which swing back out of the way when the larger doors are raised. There is no wood whatever in the construction, so that the only burnable thing in the plant is the oil and the insulation on the cables, and such wood panel boards as may be used for the mounting of the gages and instruments. The possibility of any serious fire is entirely eliminated. The It is 61 ft. by 49 ft., having 3 rooms, and basement under all. In one room are the transformers, in the next the oil switches and bus bar compartments, and in the third the lightning arresters and oil switches for the 66,000-volt circuits. The basement holds 2 oil tanks, either of which is capable of holding the oil for all the transformers.

Fuel Supply

All coal comes by train and is handled by power conveyors. At the back of the boiler house are tracks built at an incline and of such length that 5 cars of coal can be set in above the hopper which leads to the

crusher and elevator. The cars can be permitted to run down over the hopper by gravity, and the coal will dump into the hopper, passing either through the crusher, or direct to the elevator buckets, as desired. By these it is raised to the top of the coal storage bunker which is cylindrical in shape, of steel, with concrete lining and conical top and bottom. The latter is, of course, so that all the coal will deliver at the center, the former is so that the maximum amount of coal may be carried and the rain shed, and filling to the utmost is accomplished by a cross-screw conveyor leading up to the center of the roof. The capacity of the bunker is 300 tons, and the 5 cars carried on the switch track will supply the plant for a day's run at full load, so that a switching engine is needed to set in cars but once a day. After a car is emptied, it runs by gravity away from the hopper and into a switchback, which sets it on and empties storage to wait for the engine.

moved by an electric motor of 2-hp. Crocker and Wheeler make, which is operated by a hand-pull reversing switch. All coal is weighed as it is fed and a record kept of the amount. Green coal which falls from the front and through the grates, is taken by the same conveyor that handles the ashes, and dumped into a separate small bin that feeds the weigh hopper.

The stokers are Illinois chain grate, each one driven by a separate 3-hp. Crocker-Wheeler motor with a reducing gear made by the D. O. Jones Co., of Cleveland, Ohio. Water backs are installed at the rear end of the grates and connected to front and rear headers.

Water Supply

For the boilers, the water comes from the condensate from the turbine, the drip from the pipes, and make-up water at present taken from the city mains, but eventually to come from the river. Cooling water is

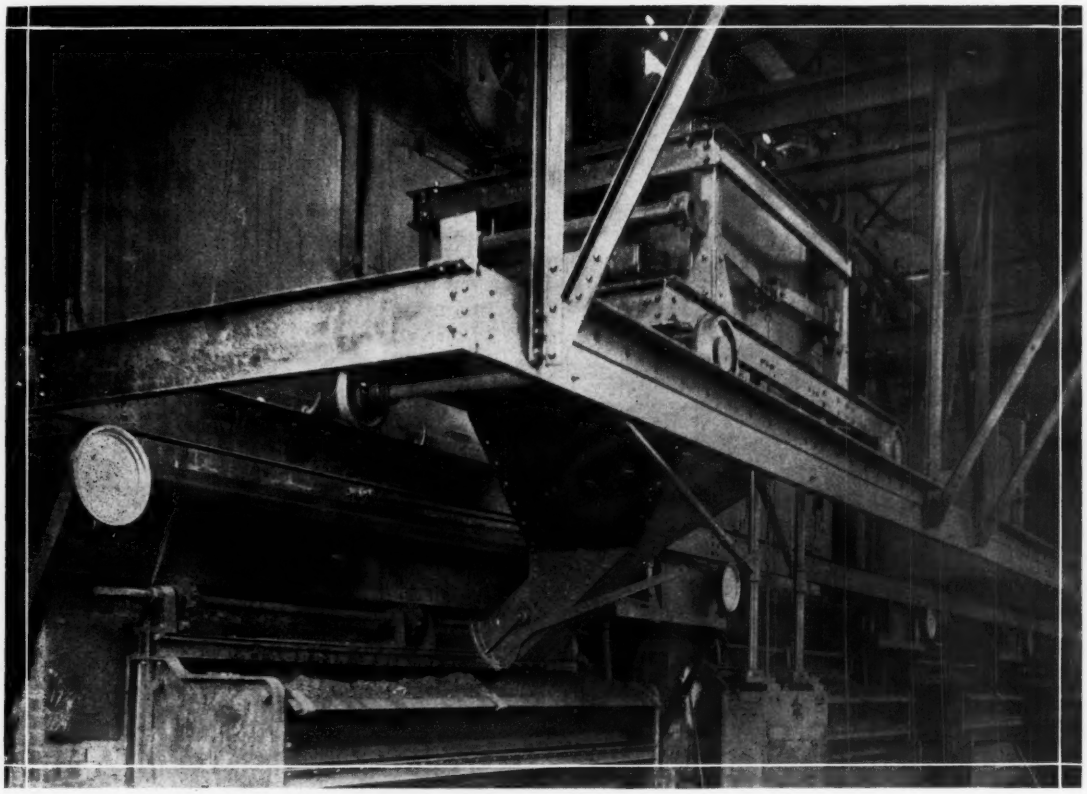


FIG. 3. FRONT OF THE BOILERS, SHOWING WEIGH HOPPER AND STOKERS

The advantage of the system, which was installed by the Jeffrey Mfg. Co., is that it requires no extra overhead room in the boiler house, permits of a large storage capacity, and does away with all manual moving of coal or ashes. The ashes drop from the stokers into concrete hoppers, are carried by flight conveyors out to a pit located alongside the coal elevator, and are raised into another storage bin, from which they run into a car set under for that purpose. From the coal bunker, the coal runs into a traveling weigh hopper, made by the Standard Mfg. Co., of Pittsburgh, whose track passes in front of the stoker hoppers, thus feeding the coal by gravity to the boilers. The weigh hopper is

taken from the river and returned by a siphon system, and the water for the cooling of the transformers is taken from the city system. This will come from the river later.

From the Alberger Spiroflo condenser, which is placed below the turbine, the condensate is drawn through 3 outlets by a 3-in. volute Alberger centrifugal pump, driven by an Alberger steam turbine, and is forced through a pipe which runs back into the boiler room basement and then along the length of the boilers and up to the 9000-gal. storage tank placed above the boilers at one end of the boiler room. Before entering that tank, it passes though a 75,000-gal. per hr. Ham-

mond meter, which records the water passing, thus registering the steam consumption of the turbine. The pump is mounted in the pit below the condenser, and at one end, so that the condensate comes to it by gravity. Steam for it is supplied from the same line that runs to the dry vacuum pump and the exhaust is into the main that runs to the Hoppes feed-water heater.

This heater is of 4000-hp. capacity to handle 138,000 lb. of water an hour in connection with the 1760 rated boiler horsepower at 100 per cent overload. It will require 21,200 lb. of exhaust steam to heat this water from 60 deg. to 210 deg. at atmospheric pressure. The details of the heater include 635 sq. ft. of trays for heating and deposit of scale-forming material, arranged in 3 double tiers, separator and oil catcher at the exhaust steam inlet and float box for control of a 6-in. feed-water regulating valve, water column and skimming device. The shell is 68 in. long, and length over all, 10 ft. 6 in. of cast iron to above the water line, about 12 in. from the bottom, and the remainder of steel plate, with cast-iron head packed by asbestos rope in a groove. The trays are of cast iron, each 2½ ft. long, 3 double tiers with 10 pans to a tier, making 60 in all. Water flows over the sides and along the bottoms in a thin film, thus getting large area of contact with the steam.

Near the condenser in the basement is a tank into which the drips are drained by Squires' steam traps, and beside it a float-governed pump, Worthington, duplex, 6 by 4 by 6 in., which takes water from the tank and delivers it through a line of pipe to a second 50,000-gal. Hammond meter located above the storage tank in the boiler room. Into this second meter comes also the make-up water pipe from the city mains, valves being provided for control so that the drain and make-up water can be measured separately and account kept. Vapor pipe and overflow from the tank are carried down beside the boiler to the basement.

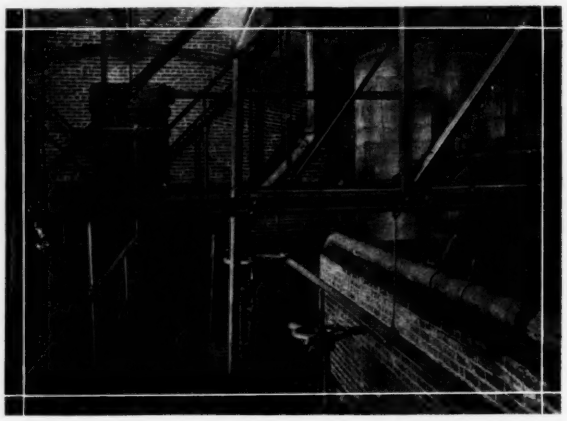


FIG. 5. VIEW ABOVE BOILERS OF STORAGE TANK AND CHIMNEY

From the storage tank, the feed water is taken to the Hoppes open heater and purifier, with bypass provided for emergencies, to an outside packed plunger pump with duplex cylinder 17 by 10 by 15 in., which delivers

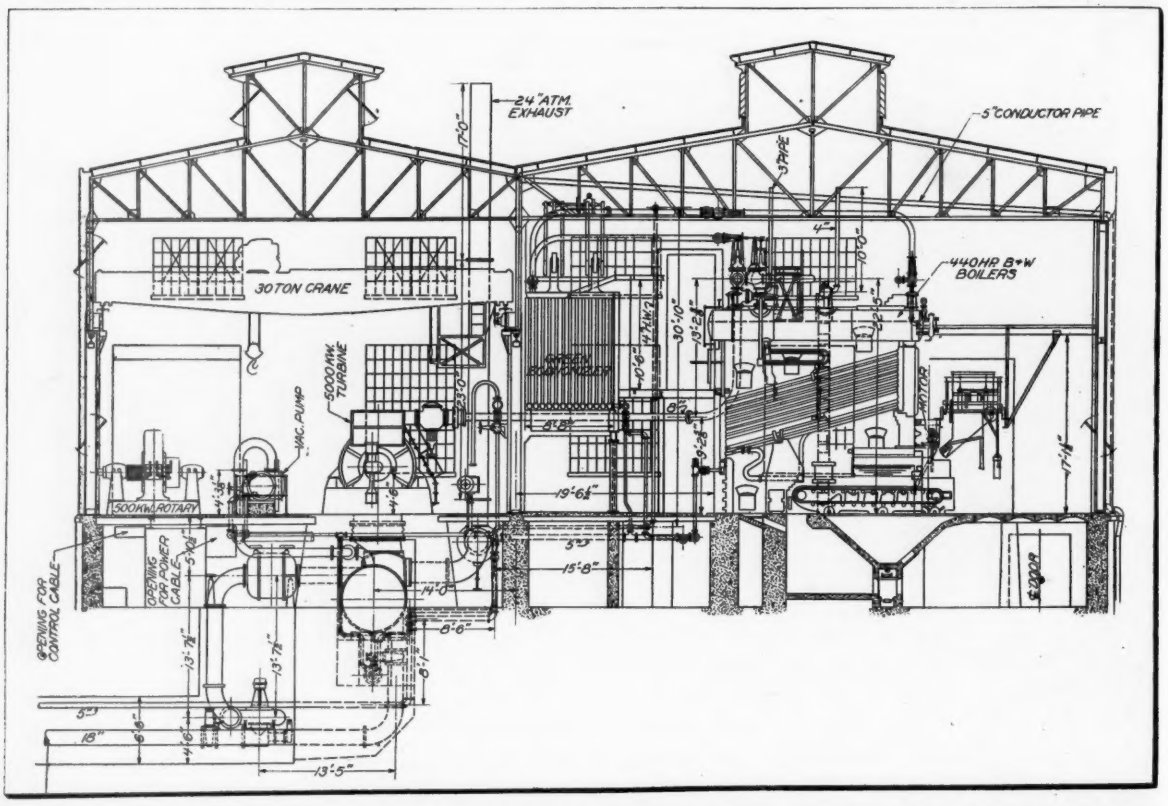


FIG. 4. SECTION THROUGH BOILER AND TURBINE ROOMS, SHOWING BOILER SETTING, PIPING AND CONDENSER ARRANGEMENT, AND ECONOMIZER LOCATION

to the feed line running above the fronts of the boilers. The feed may go direct to this line, or may be passed through the economizers and fed into the feed line at the end farthest from the pump. Connection is made from the feed line to each boiler, through a Northern feed-water regulator, or passing the regulator by direct feed, hand controlled.

Also taking its supply from the storage tank, or if desired, from the river supply, is a wash-water pump, 9 by 5 by 10 in., o.p.p. type, located alongside the feed pump, and cross-connected so that it can supply the

Fisher governors are attached to the pumps, controlling their steam supply according to the pressure in the discharge line, and thus preventing overstrain.

Boiler Plant

The boilers are Babcock & Wilcox, 3-drum type, of 440 hp., fitted with superheaters, and designed for 175-lb. pressure and 100-deg. superheat. The drums are 36 in. diameter by 20 ft. 4 in. long, and there are 21 tubes wide by 10 tubes high, making 210 4-in. tubes, 18 ft. long. Steam passes direct from the drums to the super-

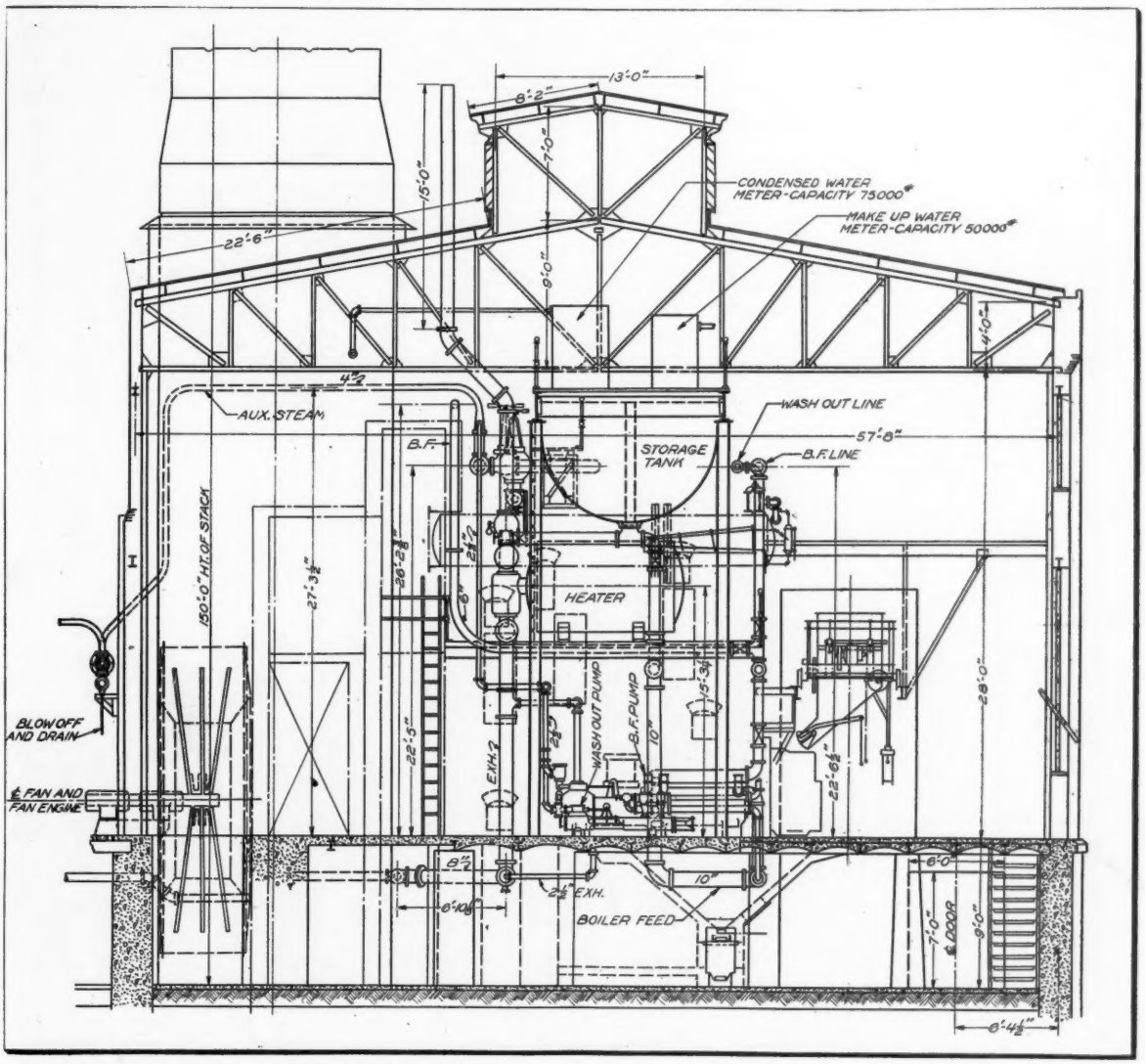


FIG. 6. ELEVATION OF STORAGE TANK, HEATER AND PUMPS, FAN AND STACK

wash-out line that runs above the boiler fronts, parallel to the feed line, or direct into the feed line for emergency feeding, the feed line being cut in two by a stop valve. At the far end, the washout line is connected into the feed line as a further emergency precaution. At each boiler a connection is carried down from the washout line to the boiler front, and a sprinkler pipe, for wetting down the coal, is run across the top of the stoker hopper.

heaters, and then to a cross-header from which the stop valve admits to an 8-in. long radius bend connected to the 8-in. main header. A Consolidated safety valve is mounted on a separate nozzle on each drum, with the discharge pipes pointed up into the turret, and drains to carry off the condensation. Also a safety valve is installed on the cross-header between the superheaters and the Nelson non-return main stop valve. A Nelson

steel gate valve is placed at the delivery from the bend into the main header, and at each outlet from the header is also a stop valve, so that no condensation can collect in any unused pipe.

At the center of the main header, an 8-in. drop main carries steam to the turbine unit, with cutoff stop valve on either side, so that steam may be supplied by the pair of boilers at either end of the room. From the top of the main header, a 4-in. branch rises which supplies the line leading to the generator room for the dry-vacuum pump, exciter and fan engines and small pumps. The feed and washout pumps are supplied by a special 2½-in. line coming from the side of the riser.

Blowoff pipes lead from the mud drum of each boiler into a blowoff main which is carried to the river, the outlet from each boiler being controlled by Duro blowoff valves, 2 in series. Blowoff lines for the water columns and gage glasses discharge into the basement to a line leading to the sewer. Drain pipes from the superheaters pass through the sidewalls of the setting and also discharge to the basement.

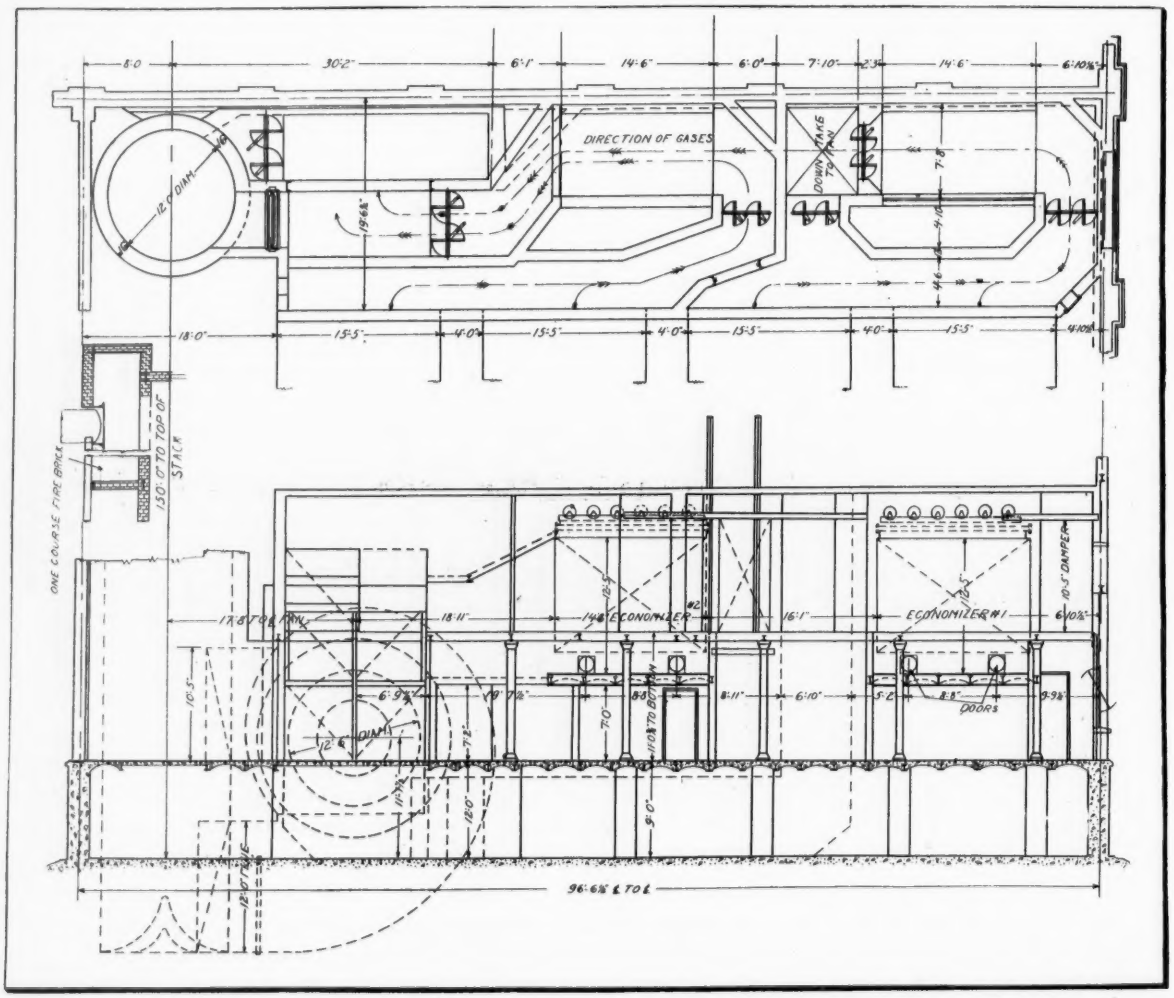


FIG. 7. PLAN AND ELEVATION OF ECONOMIZERS, WITH CROSS CONNECTING PASSAGES AND CONTROL DAMPERS

Economizers

Gases from the boilers pass to Green economizers, which are arranged in 2 series. The 2 boilers at one end of the plant feed to the economizer opposite them, and the same for the other end of the plant, but a series of dampers are arranged so that either pair of boilers may feed to the economizer at the other end, or both pairs of boilers may feed to either economizer, or either or both pairs may feed direct to the stack. Direct draft is not, however, intended, except in rare emergencies, as a large Green fan is installed to produce induced draft for the plant. The gases pass through the economizer nearest the stack and to the fan direct. From the other economizer, gases drop to a passageway beneath the floor, and then pass across and upward into the fan inlet. From the fan, the discharge is through an underground duct into the bottom of the stack.

The economizers are located back of the boilers, as shown on the drawings, and are carried on pillars, the floors being of steel beams with Ferroinclave arches covered with firebrick. A damper in the breeching of each boiler is controlled by a hand-operated rod near the rear of the boiler, so as to distribute the draft properly between the boilers, but the amount of draft is, of course, regulated by the speed of the fan, through changing the governor spring tension.

(Continued on page 451.)

Installation Of Economizers*

ARRANGEMENTS IN CENTRAL STATIONS AND OFFICE BUILDING; POINTS CONCERNING ERECTION AND OPERATION. BY WARREN H. MILLER

IN the great central station boiler plant, the conditions of economizer installation specialize because lacking the free room of the industrial plant. You have one story above the boiler room, maybe 2 of them. The natural thing to do, then, is to run your main flue along the boiler backs and reaching up to the ceiling, coming up through the next floor above to enter the economizer. The layout, shown in the Feb. 15 issue, of the Washington Street Railways power house is neat and practical in providing for the needs of its economizer operation. The designer has ordered his boilers without the usual back flue plates, and instead, comes out through the top after the final turn of his hot gases. This gives him

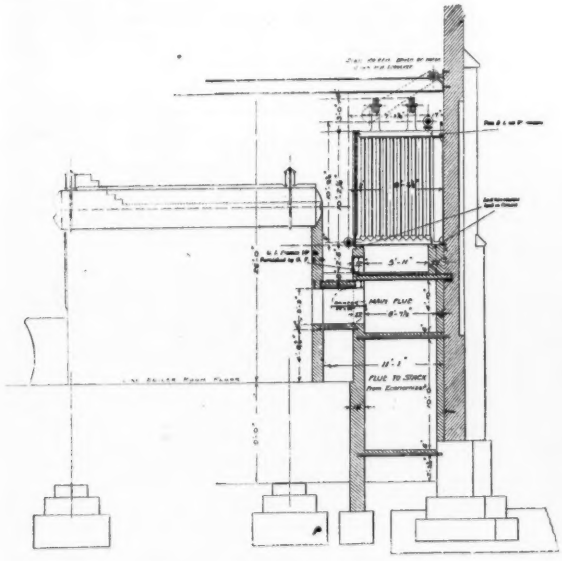


FIG. 1. POPULAR ARRANGEMENT OF ECONOMIZER IN LARGE CENTRAL STATION OF ONE STORY HEIGHT

a clear runway behind the boilers, with overhead light to look after blowoffs, feed lines and their valves, and all the main steam line fittings. The main flue is hung by tie rods from the ceiling girders, and at each end of the economizer its whole area is cut up through the floor, giving direct bypass to the chimney or through the economizer at will. The economizer is shown in 2 sections, mounted back to back, with deflectors in between, and the sectional coverings forming the outer walls. A set of windows looking out over the engine room roof give light and air to the economizer tops and scraper gears. He does not appear to have left quite enough head room or side room to take out a section in the event of cracked header or ruined tube cap seat; but by turning the section diagonally while hoisting, it can probably be gotten out. Otherwise the design is simple, economical, and practical. Of course, a leak anywhere in the outfit will shut down the whole economizer; but such are not frequent enough to warrant a dividing wall necessitating robbing the coal bin of several feet of room.

Another popular arrangement is shown in Fig. 1, where the rear basement space is used for the main flue to chimney, and the collecting flues are formed in the same foundation walls by cross flooring, above which is the economizer and its soot pan. A rear alley some 3 ft. wide is left behind the boilers, in which are the blowoff connections, or else these are put down in the basement, being led down through the boiler house floor. The cross flues from the boiler setting traverse this alley at each boiler and each has its swing damper. The rear doors for back tube caps come under these

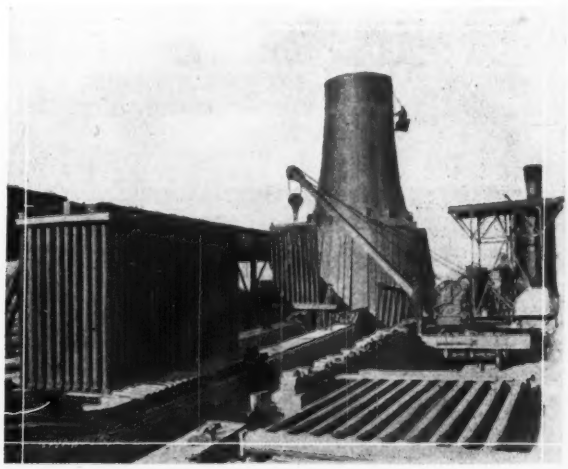


FIG. 3. VIEW TAKEN DURING ERECTION OF AN ECONOMIZER

flues and light is by both incandescents and the general overhead boiler house daylight. In the particular design shown, the flue crosses at only 4½ ft. above ground, and just where the tube caps can be manipulated is not apparent.

Where the water-tube boilers are of the cross drum type, such as the Stirling, the economizer can be backed right up against the boiler setting. A compact assemblage of boilers and economizers is shown in Fig. 2 for the Detroit Railways power plant. The foundations of the economizers form the main flue, into which all the boiler gases are admitted through holes in the brickwork. Dampers control the distribution of these gases through the economizers and to the chimney. The sectional coverings form the economizer fronts, extending out to the columns of the main engine room, an arrangement economical of floor space, handy to look after and a nuisance only when cleaning or taking out soot.

*Continued from Page 250, Feb. 15 issue.

Office Buildings and Department Stores

In office building work the general tendency is to avoid economizer installation because of the absolute unavailability of room enough to operate them properly. In New York City, out of hundreds of office building and department store plants, hardly one has an economizer. An exception that comes to mind is the Mergenthaler Linotype Co., in which there is plenty of overhead room and the economizer is installed at the rear of the boilers with the bypass flue over the boilers leaving the space in behind the rear wall clear for pipe lines and boiler cleaning. As a general rule the coal used is cheap, running about $2 a ton fired, and the pressures are low, so that the stack temperatures are not high enough to warrant any great rise in temperature in the economizer. The combined result of restricted space and small return upon investment has, therefore, discouraged the use of economizers in city office buildings and department store plants.

pletely filled, it is then swung into the main feed line so that its temperature is never much over 200 deg. F. I am rather uncertain as to what the effect of imprisoning this steam, which is raised when the economizer is being filled, would be. A good deal of it is formed, and if introduced to the boilers at boiler pressure via the feed line would, to my mind, be apt to start surging.

The feed water enters at the bottom header and ascends gradually through the 400 or 600 tubes, rising more under the influence of temperature than anything else. The hottest of it collects in the top headers and then ascends a short, pressure-riser which prevents air-bound sections, and thence to the boiler feed checks. This riser is flanged and requires a flanged angle valve, while a similar one controls the inlet. There is also required a blowoff valve similar to the ones on your boilers, that is to say, some sort of special disc valve with pilot to keep grit and scale from getting under its seat. No additional blowoff cock will be needed. This valve goes at the other end of the inlet header and is

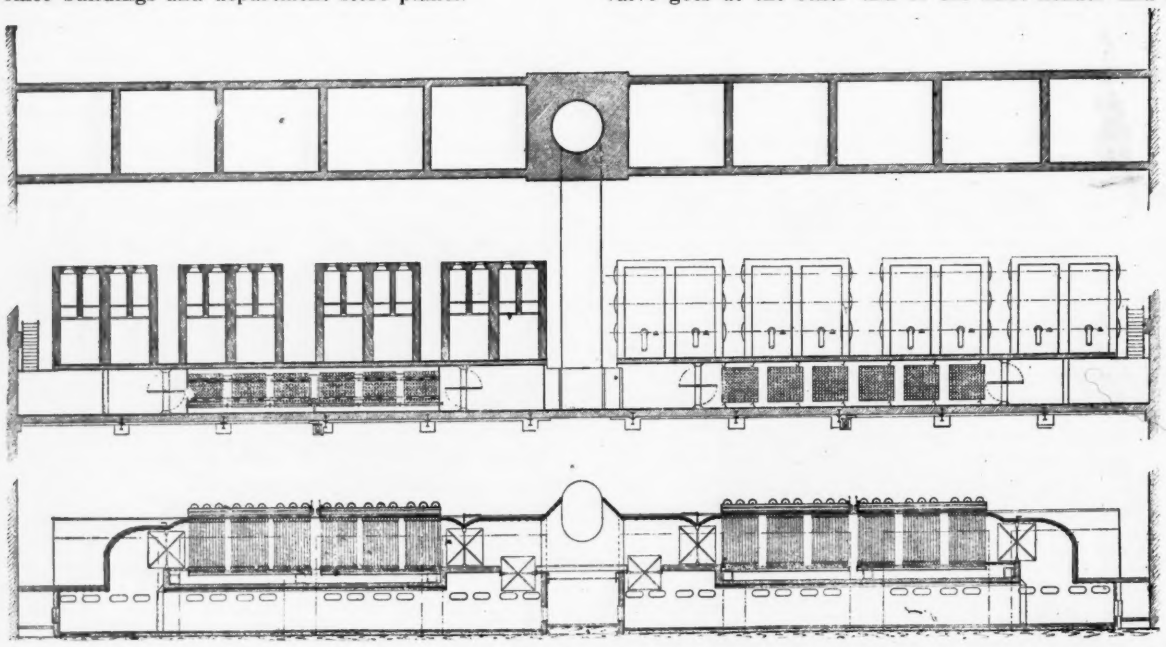


FIG. 2. ECONOMIZER INSTALLATION WITH CROSS DRUM BOILERS IN DETROIT STREET RAILWAYS PLANT

Economizer Erection and Operation

To put the economizer into operation, if it is ready when the plant starts, simply fill it when filling the boilers and raise steam with the economizer dampers open and bypass dampers closed. If putting it in service after cleaning or repairing a leak, I find it is impossible with any known type of damper to prevent the "down" economizer tubes from getting nearly as hot as if the dampers were open. The result is that a great deal of steam is formed while pumping up, and in a small plant it is quite a problem to spare the boiler feed pumps long enough to get this job done between regular boiler feedings. In order to forestall any steam hammer or water hammer when putting the economizer into service I usually fill it with the safety valve open, allowing the steam, which raises as it is being filled, to escape at atmospheric pressure. When the economizer is com-

more or less of a joke; for, while it is supposed to blow down the 400 tubes, as a matter of fact what really comes out is fresh feed water coming along the header from the inlet valve, as you can convince yourself by feeling its temperature. If it blows down into the works sewer, however, and *not* into the boiler blowoff main, it comes useful in running off scale and mud when the economizer is being cleaned.

In erecting the economizer, one make has flanged sections which bolt at right angles into flanged manifold headers, the gaskets being asbestos. In the other the headers used to bolt together sidewise, an asbestos gasket going between the faces. The result was that endless trouble was experienced in getting tight joints for the sections; all had to be exactly parallel for the gaskets to make up tight. As the top or bottom headers were sure to gain more or less on each other in erecting.

they would get out of perpendicular and no amount of setting up on the bolts would make the gasket tight. Even if the foundation was exactly level and true-surfaced, slight differences in thickness of the gaskets would be sure to throw you out of plumb. The company finally abandoned this construction for an all-metal nipple union joint. As it was quite hopeless to expect these nipples, 14 ft. apart across the diagonal of the sections, to come facing exactly true, the upper connection was made a cast-iron U with metal nipples drawn by bolts into corresponding seats in the upper headers. Trouble from air-bound sections with this scheme was predicted; but, so far as the writer has been able to ascertain, the device worked out all right. Air-bound sections result from the entrained air in the feed water rising to the top of the header, where, if imprisoned by any cause whatsoever, the water in that particular section will rise no further since the feed water has 400 other paths to take to reach the outlet. As said before, the uniform flow in all the sections is entirely due to gravity and temperature, the tendency of all the feed water being to go up through the first few headers. An air pocket will therefore put any section permanently out of use, so the design of the top header, with the final riser to the outlet valve, must be such as to allow the ready escape of the free air driven out of the water by the heat.

(To be continued.)

Heating and Ventilating Large Buildings

CARE AND MANAGEMENT. BY CHARLES L. HUBBARD

IN this article it is proposed to touch only upon those matters which relate to the heating side of the equipment, starting at the point where the steam is delivered from the boilers or engines to the heating system. In a general way, the apparatus making up this part of the plant is comparatively simple and requires little care except cleanliness and occasional adjustments as may be necessary. If the radiation is properly proportioned and located, the failure of any room to heat up as it should will probably be due to imperfect air venting.

In case of complaints of this kind, the first thing is to examine the air valve, and if the system is operated under low-pressure steam, it should be so adjusted that there will be the least trace of vapor issuing from it when the radiator is steam filled. If the air valves are connected with a drip line, the union connecting the valve with the piping should be unscrewed so that the amount of steam issuing from the valve may be noted while adjusting it. This will take a little extra time, but if the valve is properly adjusted at first it will save additional trips to the room giving trouble.

If a vacuum system is employed, the trouble may be due to a failure of the automatic return valve to work properly, thus allowing the air and condensation to accumulate in the radiator. Sometimes simply rapping the valve will start it working, while in other cases it may be necessary to remove the cap from the valve in order to get at the interior, shutting off steam from the radiator, of course, before doing this.

In case an air-line vacuum system is employed, adjust the air valve the same as in a pressure system. It is also a good plan, in any case, to see if the supply valve is open, even before inspecting the air or return valve. Tenants will often send for the engineer, in case the radiator fails to work properly, without even taking the trouble to see if it is turned on.

The engineer should provide himself with cuts and descriptions of the special valves used in his building and obtain from the makers careful instructions regarding the care and adjustment of them.

This, however, applies to all special equipment in connection with the plant.

In case of hot-water heating, the shut-off valves should first be examined to see that they are open, and the radiator air vented if the system of piping is such as to require it. If this fails to remedy the difficulty, it may be that the flow of water is short-circuited through the radiators on the lower floors, in which case they should be throttled sufficiently to force the water through the radiators higher up on the line. Sometimes the flow will be weak through all of the radiators on a single pair of risers, as indicated by their failure to heat the rooms properly. This may be overcome by changing the adjustment of the valves at the bases of the risers; opening those slightly in the weak risers and closing down a little on those immediately beyond.

In case of a low pressure steam system, the pressure carried should be only just enough to circulate the steam through the most distant radiators; this will vary somewhat in different buildings, but with a well designed system of piping should not exceed 1 lb., or 3 lb. at the most. This will prevent an objectionable back-pressure on the engines and also tend to circulate more quietly. There is little to be gained in the way of heat by raising the pressure to 5 or 6 lb., as a rise from 1 to 5 lb. only increases the amount of heat given off from a radiator in the ratio of 1 to 1.07. The back pressure on an engine exhausting to the atmosphere is about 2 lb., due to friction, etc., so that if the pressure in the heating system is not carried above this point, there will be no appreciable effect on the engine in utilizing the exhaust steam in the heating system as compared with turning it outboard.

Both reducing valve and back-pressure valve should be inspected occasionally to see that they are in working order. When the latter is located in the main exhaust riser at the top of the building it is apt to be neglected. If the valve fails to open properly, a high back pressure may be thrown upon the engines at times when the demand for steam in the heating system is small. On the other hand, should it fail to close properly it will result in a waste of steam which must be made up directly from the boilers.

When the oil is removed from the exhaust simply by passing the latter through a separator, the condensation

from the heating system should be tested once in a while to see that the oil is thoroughly removed. This may be easily done by evaporating a sample of the water in a porcelain dish. If a dark residue is left in the dish after evaporation has been completed, it indicates the presence of oil. In cases of this kind the condensation should be passed through some form of settling tank or filter before returning to the boilers.

In case of a hot-water system, operating under forced circulation, the engineer should prepare a schedule of water temperatures for corresponding outside conditions. This can be done only by carefully noting the water temperatures necessary to warm the building with different outside temperatures, taking into account winds and cloudy weather. After keeping careful records for 1 or 2 seasons, a schedule may be prepared which will be of great assistance in operating the plant. The water must, of course, be circulated at a temperature sufficiently high to warm the coldest rooms in the building, and other rooms must be regulated by throttling the supply valves at the radiators, although this condition will be largely provided for in proportioning the sizes of the radiators for the different rooms. The method of regulating the temperature of the building may also be determined to some extent by the type of apparatus.

In case of a motor drive, it will probably be best to operate the pumps at a constant speed and vary the temperature of the water, while with an engine drive, it may be found more convenient to do at least a part of the regulation by varying the speed of the pump.

These details are best worked out by experiment in each particular case.

In a similar manner the engineer will soon learn how many sections of his main heater to carry for different outside temperatures, in order to raise the air supply to the desired point.

All pumps, fan engines and motors should be kept clean and in perfect adjustment, and extra care should be taken when they are in rooms through which the air supply is drawn, or the odor of the oil will be carried to the rooms. All steam traps should be examined at regular intervals to see if they are in working order, and upon any sign of trouble they should be taken apart and carefully cleaned.

Systems of automatic temperature control are usually kept in adjustment by the makers, this commonly being done free of charge for a given period after installation. As the mechanism is delicate the makers prefer to make all adjustments themselves, rather than have unskilled persons meddle with it; however, a competent engineer should familiarize himself with this equipment and be able to make simple adjustments of thermostats, etc., without calling in outside assistance. This refers especially to setting thermostats for different temperatures and starting them should they stick slightly and fail to operate within their normal range.

Air washers are simple pieces of apparatus and require a comparatively small amount of attention.

The principal matters to be noted are flushing out the spray heads frequently to keep them from becoming clogged, and to change the water in the tank regularly and as often as may be required to keep it in good condition. When the outside temperature falls below freezing, care should be taken to see that the tempering coil is in working order. This is usually kept in use constantly, adding sections of the secondary coil as more heat is needed, for in this way there is little danger of overlooking it and damaging the apparatus by freezing. The best pressure to carry on the spray heads, and any other special directions necessary to secure the best results, should be obtained from the makers.

Ventilating fans require little attention except to keep the oil cups filled and the parts clean. They should be run at the speeds necessary to deliver the full amount of air for which they were designed, and be kept in continuous operation during the regular hours of occupation, unless especially directed otherwise by those in charge of the building.

If the ventilating system is of any considerable size, as in a school building, hospital, library, etc., the engineer should be provided with an anemometer for measuring the volume of air supplied to the rooms. This will not only assist him in adjusting the dampers at the bases of the supply flues, but will show at once, in case of complaint, whether or not a room is getting its full supply of air. An anemometer consists of a series of flat vanes attached to an axis, and a series of dials. The revolution of the axis causes a motion of the hands in proportion to the velocity of the air, and the result in feet in any given length of time can be read directly from the dials.

Measurements for the total air supply to a building are commonly made at the inlet windows, or shaft, near the fan, while the supply to an individual room is measured at the register.

For approximate results the anemometer may be slowly moved across the opening in either vertical or horizontal parallel lines, so that readings will be made up of velocities taken from all parts of the opening. Readings 1 min. in length are usually sufficient for rough work.

When taking measurements of air-flow at grilles or registers, the anemometer should be held about 4 in. from the face of the fretwork, as at this distance the jets of air issuing through the various openings become practically united in a solid stream or current, having a sectional area equal to the over-all or gross area of the register face.

When starting up a new plant, the ventilating system should be put in proper balance by a suitable adjustment of the dampers in the distributing ducts and flues, and when once fixed, they should be marked and left in these positions. The temperatures of the rooms should never be regulated by closing the inlet registers and thus reducing the air supply, but by the use of mixing dampers or manipulation of the valves on the steam coils.

In case of a large school, hall, or similar building, provision should be made for air rotation, that is, the arrangement should be such that the same air may be taken from the building and passed continuously through the fan and heater. In warming up a building of this kind in the morning, air rotation should be practiced until about 15 min. before it is to be occupied, after which the full volume of fresh air should be taken from out of doors. This should be supplied at a temperature of 70 deg., being maintained by the proper use of shut-off valves, thus running a greater or less number of sections of the main heater.

Sometimes a by-pass damper is provided in connection with the main heater, in which case the steam valves may be used for the general regulation and the damper for the finer adjustments of temperature. A dial thermometer of large size should be placed in the side of the main warm-air duct near the fan, so that the temperature of the air delivered to the building may be easily noted by the engineer.

Combustion of Coal and Smoke Abatement*

Brief Statement of Combustion Requirements; Comparison of Smoke-Producing Constituents of Several Coals; Means Employed for Eliminating Smoke; Furnace Construction; Methods of Firing. By Samuel B. Flagg

PART of the work of the Federal Bureau of Mines, with which the author is connected as engineer, is the study of economical and smokeless combustion of fuels, and particularly of various kinds and grades of coal. In the present paper there will be briefly presented results of a series of tests conducted at the Bureau's experiment station at Pittsburgh for the purpose of studying the effect of different features of furnace construction and operation upon efficiency and smoke emission. We may then consider an analysis of the combustion processes under the conditions which existed and the possibilities of developing the method so as to make possible the more accurate design of hand-fired furnaces.

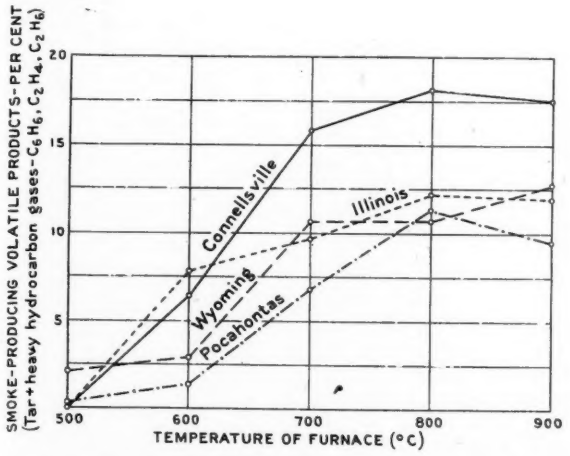


FIG. 1. QUANTITIES OF SMOKE-PRODUCING VOLATILE MATTER DISTILLED FROM SEVERAL COALS

The presence or absence of smoke at the top of any stack is not of itself a proof that the plant is being inefficiently or efficiently run, or even improperly or properly operated, although it is popularly so considered. Many boilers which are being operated with little or no smoke would show low over-all efficiency if tested, whereas, others from which much smoke is being emitted would show that the fuel is being economically utilized. Such cases may be said, however, to be the exception rather than the rule, for the smoky stack is usually an indication of inefficient or improper operating conditions. This statement is borne out by the results of many tests conducted at the Government fuel-testing plant which was maintained at St. Louis during the years 1904-1906.

*A paper read before the Cleveland Engineering Society, March 10, 1914. Published by permission of the Director of the United States Bureau of Mines.

Requirements for Complete Combustion

If the requirements for complete combustion of coal are complied with, it is obvious that smoke will be prevented, for the reason that smoke is an indication of incomplete combustion. These requirements are probably known to all of you, so they will be merely mentioned. They are: (1) that the necessary air for combustion be supplied, (2) that the gasified fuel and the air be intimately mixed, and (3) that the mixture be at a temperature at or above that at which the combustible gas will ignite or burn.

In order that these conditions may be realized, it is necessary that the furnace or boiler and setting be properly constructed and properly operated, and the quantity of smoke in the atmosphere is evidence

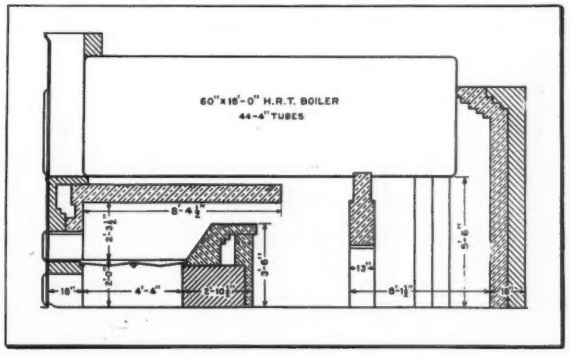


FIG. 2. HAND-FIRED BOILER SETTING WITH BRICK ARCH OVER GRATES

of the fact that the problem of meeting the requirements is not as simple as the statement of it. The difficulty of obtaining the intimate mixture of air and combustible gases before they come in contact with surfaces which lower the temperature below the ignition point, is the greatest to be overcome, and it is as to the proper furnace construction to bring about this mixture that we are today greatly in need of information. The results that have been obtained have come largely through the application of cut-and-try methods, and comparatively little has been done to determine just what the task involves, although it is easily seen that the factors to be considered vary according to the operating conditions, and especially with differences in the fuel used.

Investigations made by H. C. Porter and F. K. Ovitz and by others show decided differences in the quantities of smoke-producing volatile matter distilled or driven

off from different coals, or even from the same coal under different conditions of heating. Curves showing the quantities determined for several coals are shown in Fig. 1. To illustrate, if it is assumed that Pocahontas, Connellsville, Zeigler (Illinois), and Dietz (Wyoming), coals can be burned with the same over-all efficiency, the quantities of these coals required to evaporate a given quantity of water will be as 1 : 1.05 : 1.23 : 1.39. If the temperature of the furnace in which these coals are burned, is about 1650 deg. F., the quantities of smoke-producing volatile matter driven off will be as 1 : 1.93 : 1.55 : 1.86. The furnace and the method of operation must therefore be adapted to take care of nearly twice the quantity of smoke-producing gases and vapors if Connellsville coal is to be used instead of Pocahontas.

The problem is further complicated in that the volatile matter of the Connellsville coal is of a different character from that of the Pocahontas fuel and requires more air for its combustion. The experiments show, for instance, that the quantity of tarry matter, which is most difficult to break down and completely burn, from the

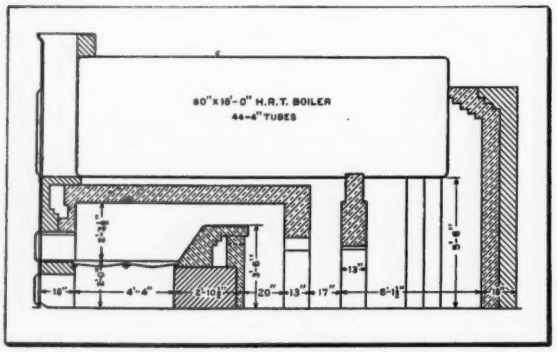


FIG. 3. HAND-FIRED BOILER SETTING WITH FURNACE ARCH AND DEFLECTION ARCH

Connellsville coal, would be almost double that from Pocahontas. If the Zeigler (Illinois) and Connellsville coals, tested by these men, be compared in a similar way, it will be found that, although the amount of Illinois coal required to evaporate a certain number of pounds of water will be more, the quantity of smoke-producing volatile matter from it will be only 80 per cent, and the quantity of tarry matter only 35 per cent of that from the Connellsville coal.

Methods of Eliminating Smoke

Possibly the most commonly-tried way of meeting the smoke difficulties has been to purify the gases, or remove in some way the solid particles, and the schemes of this sort vary widely as to complication of detail and soundness of principle. The rather recent effort to adapt the electric precipitation process to this problem is probably the most conspicuous attempt along the line of purification.

Another method which has been used in many cases is to lower the rate of combustion per square foot of grate area, by either using more boilers to do the work, if it be a steam power plant, or increasing the grate area per boiler.

The use of coals of lower volatile matter content as a means to the end of reducing or preventing smoke emission is too familiar to require more than passing mention, and the same may, in large measure, be true of increasing the supply of air—particularly the admission of extra or supplementary air into hand-fired furnaces immediately after times of firing.

In many cases the use of better mixing devices has made it possible to obtain complete combustion and prevent smoke, without the admission of any more air. This is especially true of hand-fired furnaces, although it applies to mechanically-stoked furnaces as well. Other installations may be of such a character that the mixing devices alone will not accomplish the desired results, but will if supplementary air is admitted to the furnace after firings.

Still another method is employed, especially in firing with mechanical stokers—the decrease of the rate of heating the fuel so as to make it gradual and more nearly uniform. This method may also be used in some measure in hand-fired furnaces.

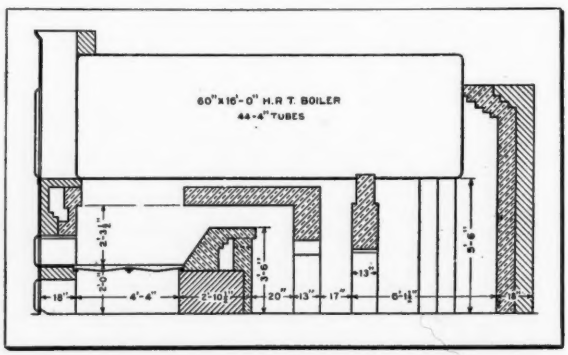


FIG. 4. HAND-FIRED BOILER SETTING WITH DEFLECTION ARCH AND SHELL OVER GRATE EXPOSED

All of the foregoing methods or ways of abating smoke may be included under one of 2 general classes; they are either temporary or makeshift, or they are permanent or scientific. Obviously in the plant which is soon to be rebuilt, it is justifiable to employ temporary or makeshift means to lessen the smoke emission, whereas, in a large plant of modern design, the adoption of the permanent methods would ordinarily be the proper policy.

In plants which are mechanically stoked, the lessening or the prevention of smoke emission is accomplished largely through the decrease of the rate of heating of the coal or through the better mixing facilities, or both. The real advantage in feeding the fuel at a fairly uniform rate and with some degree of continuity, as is done in most mechanical stokers, is that in this way the rate of heating can be made slower and the volatile matter is therefore distilled at a slower rate.

Use of Supplementary Air

In the last few years, especially, the efforts to obtain complete combustion by the use of supplementary air, by improving the facilities for mixing air and combustible gases, and by decreasing the rate of heating the coal, have been many.

In some respects the problem of obtaining complete and at the same time efficient combustion conditions is much more difficult in the case of hand-fired furnaces than where the stoking is mechanically done. In spite of this fact, however, the design of mechanically-fired furnaces has been given the greater amount of real scientific study because of the greater individual importance of the large size plants, in the most of which it is profitable for other reasons to install mechanical equipment.

Some 4 yr. ago the Bureau of Mines, realizing the need of more complete information concerning the effect upon efficiency and smoke emission of differences in methods of firing or of certain features of design of hand-fired furnaces, planned a series of tests which have since been carried out, and a report of the tests and the results obtained is now in press. Figures 2, 3, 4 and 5 show the several arrangements of the setting with which tests were conducted, and Table 1 gives the principal

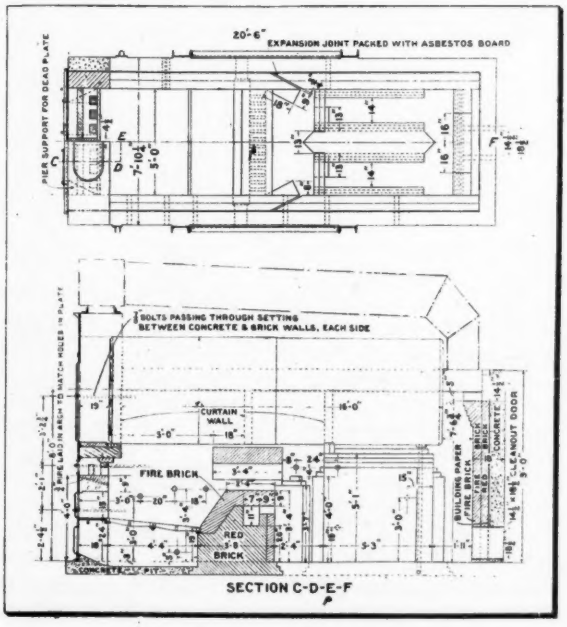


FIG. 5. HAND-FIRED BOILER SETTING WITH DIVIDED COMBUSTION CHAMBER

results. With each arrangement of setting, trials were made to ascertain the effect of the method of firing, and with some of them to observe the effect of supplementary air admitted into the furnace or combustion chamber. The rate of combustion was practically the same—approximately 15 lb. per square foot of grate per hour—for all tests and the coal, although it was not all produced at one mine, was all slack coal from the Pittsburgh seam and of the same general character throughout. A general discussion concerning the effect of the several features of these furnaces and of the method of firing is given in the report which has been mentioned, and will soon be ready for distribution. It will be noted that at different times in these experiments each of the 3 following methods of lessening smoke were employed, using extra air, better mixing facilities, and decreasing the rate of heating; and the effects of each in decreasing the smoke emission are evident.

To determine just what changes are taking place in a furnace is always a difficult, if indeed it is not an impossible task. On account of the observed difference in smoke emission under the different firing conditions, however, an effort was made to analyze the combustion process, insofar as the rate of distillation of the volatile matter was affected by the method of firing.†

Comparison of Firing Methods

In the tests conducted with the several arrangements of setting it was observed whenever the firing was done by the alternate spreading method that, although the total period of smoke emission was about the same, the duration of the dense smoke emission was greater than when the coking method of firing was employed.

TABLE I. PRINCIPAL EFFECTS OF DIFFERENT METHODS OF FIRING

	Series No.	Auxiliaries Used.									
		None		Air Over Fire		Air through bridge wall.		Steam jets over fire		Steam jets & air over fire	
		Coking	Spreading	Coking	Spreading	Coking	Spreading	Coking	Spreading	Coking	Spreading
Effic. of Boiler and Grate (%)	1	55.9	60.0	59.7	62.6	56.0	61.4	57.7	56.4	60.4	58.9
	2	57.1	59.7	59.6	60.4	61.1	61.8	57.0	59.8	60.2	60.8
	3	62.1	60.9	62.6	63.4	62.3	64.8	62.0	61.7	66.1	64.6
	4			57.9	61.6					58.6	62.5
	5			65.7	67.0					68.0	65.5
	6			64.7	64.3					63.0	63.4
Average density of smoke % black	1	4.1	20.0	3.0	15.8	4.0	20.8	7.0	38.6	11.0	27.3
	2	10.4	25.4	11.1	20.0	9.0	16.1	14.3	31.0	9.7	21.2
	3	15.7	23.9	10.8	14.6	7.8	15.8	13.0	29.2	6.0	21.4
	4			4.9	14.0					3.0	11.3
	5			9.8	12.4					4.8	16.5
	6			4.2	20.4					3.8	19.6
Max. Minn. of dense smoke per hr.	1	2.5	14.5	2.0	13.5	2.0	14.5	6.2	30.0	7.5	23.0
	2	10.0	18.5	6.5	18.0	7.0	14.0	10.5	23.5	6.5	16.5
	3	13.5	18.5	7.0	11.0	4.8	8.0	9.0	23.5	6.5	18.0
	4			6.0	17.5					4.0	14.5
	5			6.0	7.0					3.0	11.0
	6			3.5	16.5					3.0	15.0
Flue Temp Deg. F.	1	601	534	575	536	576	541	561	545	549	556
	2	630	550	561	539	576	568	577	542	567	554
	3	568	561	556	537	549	529	542	526	534	500
	4			586	583					587	563
	5			574	559					526	547
	6			537	563					560	559
Carbon Dioxide	1	8.4	11.5	8.0	11.5	8.2	12.3	8.9	12.3	10.0	12.3
	2	9.2	10.7	9.4	10.6	9.5	11.4	8.5	12.6	9.4	11.4
	3	10.8	11.9	11.0	11.1	9.8	12.1	11.0	12.8	10.7	14.0
	4			8.9	10.4					8.4	10.5
	5			10.6	10.4					11.4	11.1
	6			11.6	12.6					10.3	11.6
Draft of Breaching.	1	0.35	0.20	0.33	0.18	0.28	0.15	0.27	0.17	0.20	0.14
	2	0.30	0.17	0.25	0.18	0.22	0.16	0.24	0.12	0.23	0.13
	3	0.19	0.19	0.18	0.18	0.25	0.17	0.21	0.12	0.17	0.12
	4			0.23	0.18					0.24	0.18
	5			0.15	0.13					0.13	0.12
	6			0.34	0.30					0.41	0.34
Quality of refuse % clinker	1	49	70	52	67	49	72	59	64	53	66
	2	52	58	53	65	55	62	62	70	63	69
	3	66	63	46	56	58	61	56	59	54	64
	4			41	45					32	59
	5			58	50					45	49
	6			35	52					27	55

The furnace temperature was also higher when the firing was by the first-mentioned method. In starting to make the analysis it was assumed that for any one coal, each arrangement of the furnace imposed a certain limit to the capacity of the furnace to burn volatile matter; in other words, that when the rate of distillation reached a certain figure some of the volatile combustible would begin to escape unburned and appear as smoke, even though the supplementary air-admission openings were used. Conversely, when the rate of evolution or distillation from a newly charged lot of coal decreased to this critical figure, smoke would cease to appear at the top of the stack.

In drawing the hypothetical curve of distillation of volatile matter for the spreading and for the coking method firing, Fig. 6, it was therefore assumed that points

†For assistance in making this analysis, acknowledgment is due G. C. Cook, of the Bureau.

"x" on both curves represent the critical rate and have ordinates of the same height, and each has an abscissa representing a time interval of 2 min. after the firing starts, since ordinarily no smoke was observed with either method of firing after 2 min. after the firing took place.

Point "y" at the end of the 5-min. period (upper curve) was arbitrarily assumed to represent the rate at which the volatile matter was being evolved at the end of the period, and the general form of the curve for the spreading method was taken to be somewhat similar to that shown. The curve representing the conditions in the furnace as a whole, however, is made up of curves representing the distillation on the 2 sides of the grate, which latter are 5 min. behind one another, since this was the firing interval when the alternate

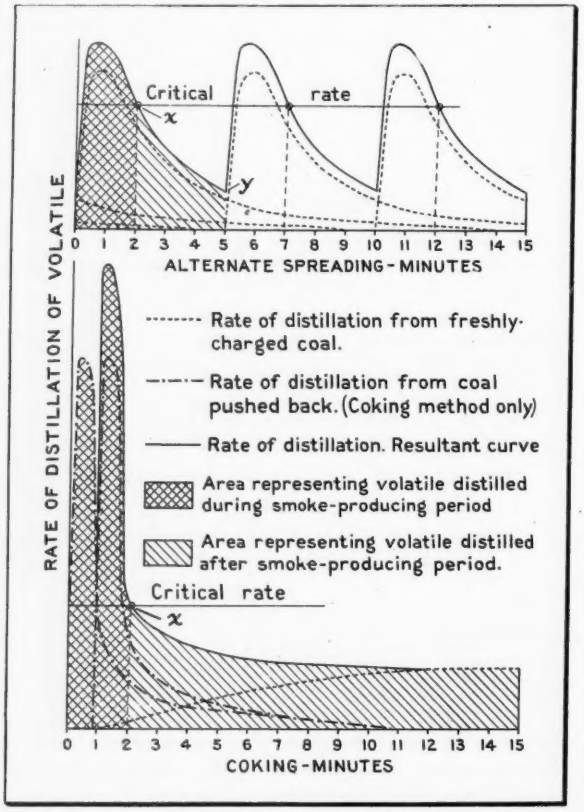

Critical rate
x
y
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
ALTERNATE SPREADING-MINUTES
RATE OF DISTILLATION OF VOLATILE
Rate of distillation from freshly-charged coal.
Rate of distillation from coal pushed back. (Coking method only)
Rate of distillation. Resultant curve
Area representing volatile distilled during smoke-producing period
Area representing volatile distilled after smoke-producing period.
Critical rate
x
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
COKING-MINUTES

FIG. 6. CURVES OF RATE OF DISTILLATION OF VOLATILE MATTER FOR A HAND-FIRED FURNACE UNDER 2 CONDITIONS OF FIRING

spreading method was employed. The form of the resultant curve was therefore adjusted to correspond with curves for each half of the grate drawn to represent as nearly as possible the conditions observed during the tests.

The other resultant curve (lower curve, Fig. 6), representing the coking method of firing, was prepared in a similar way. Whenever this firing method was employed, observations showed that the most rapid distillation of volatile matter occurred immediately after the partially coked coal on the front of the grates was broken up and pushed back. At this time, the evolution was at a high rate, but the high rate was maintained only a short time. The newly-charged coal, of course, began to distill its gassy constituents as soon as it was placed in the furnace, but at a slowly increasing rate, which became almost constant during the latter part of the 15-min. firing period.

Under the conditions as indicated by these curves, the smoke-producing period would be 6 min. out of 15 when the firing was done by the alternate spreading method, and 2 min. out of 15 when the coking method of firing was employed. The height of the rate of distillation curve during the smoke producing period in the latter case might seem to indicate that the most dense smoke would be emitted under the coking method of firing. As a matter of fact, ordinarily the most dense smoke was made when the other method was employed, and the explanation probably is that the firing doors which must necessarily be open for a longer time in order to fire by the coking method, admit large quantities of air during the time that the most rapid distillation takes place.

While these curves are based on assumptions, the truth of which has not been demonstrated, the correspondence with observed conditions would seem to justify the conclusion that they are approximately representative. One point of particular significance is that from the coal fired in any 15-min. period, 61 per cent of the volatile matter is distilled at a rate above the critical rate if the firing is by the alternating spreading method, whereas, the per cent is only 41, if the other method is employed.

The author's idea in attempting this analysis was that it might make more clear the nature of the problem to be dealt with in hand-fired furnaces, and we may therefore stop to consider what the study has revealed. The wide variation in the rate of distillation under either condition of firing which is shown by the curves, certainly emphasizes the importance of adequate mixing facilities. In the tests that have been mentioned, the gas analyses show, in most cases, 60 to 75 per cent excess air with no CO or other combustibles, but the inability to obtain smokeless combustion proves the inadequacy of the brick arches and piers to mix properly the air and volatile combustible matter at the times of most rapid distillation. The admission of supplementary air through openings at the front of the furnace immediately after times of firing, made a marked difference in the smoke emission, and demonstrated the effectiveness of the expedient.

Some idea of the difference which this supplementary air admission made, may be gained from the 2 views of the stack serving the boiler in question, Figs. 7 and 8. The smoky condition obtained immediately after a firing had been made without using the air openings at the front; the other view, taken about the same length of time after another firing of approximately the same quantity of coal was made in a similar way, except that supplementary air is admitted. It should not be inferred, however, that it was possible to prevent smoke emission at all times by this means, for such was not the case.

The importance of controlling the rate of distillation and of keeping it as nearly uniform as possible, is also illustrated by the curves, for in one case the volatile matter is being distilled at a rate above the critical rate

for only 2 min. out of 15, or about 13 per cent of the time, whereas, in the other case the distillation at the excessive rate covers a period approximately 3 times as long. The principal advantage of the mechanical stoker, in so far as smokelessness is concerned, as has already been pointed out, lies in the approximate uniformity of the rate of feeding the coal and of distillation of the volatile products. If the same quantity of volatile matter represented by the curves that have been considered were driven off at a uniform rate, the critical rate for that furnace would not have been exceeded and the combustion would have been smokeless. To obtain this uniformity of rate of distillation in hand-fired furnaces, however, is impossible, although the variations may by proper construction and operation of furnaces be greatly reduced.

In any furnace which is to be fired by the spreading method, frequency of firing tends somewhat to reduce the variations in rate of distillation, but the charging of green coal into a hot furnace in a comparatively thin layer on top of hot coals must inevitably result in a rapid distillation of the volatile products. It is therefore to be expected that the mixing facilities and the supplementary air must play the principal part in preventing smoke emission if that method of firing is to be used. This statement should not be construed to mean that the rate of distillation will not be affected by the

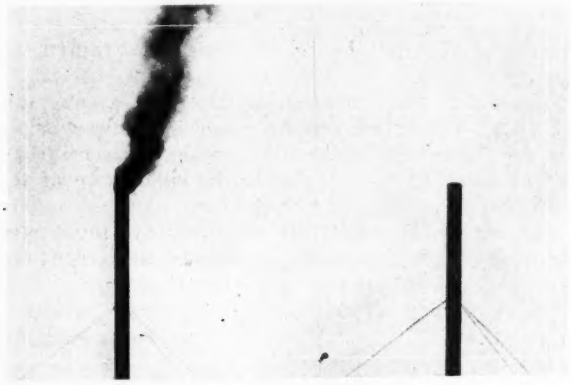


FIG. 7. VIEW OF STACK OF HAND-FIRED BOILER JUST AFTER FIRING; NO SUPPLEMENTARY AIR USED

FIG. 8. SAME STACK AS IN FIG. 7, JUST AFTER FIRING; SUPPLEMENTARY AIR USED

construction of the furnace; in fact, proof that it is so affected was furnished when the change was made from the setting shown in Fig. 3 to that in Fig. 4. The lowering of the furnace temperature which was accomplished by the removal of part of the arch, made a marked difference in rapidity of distillation and in smoke emission.

Use of the steam jet as a device for mixing air and combustible gases is so well known that it will be unnecessary to discuss its effectiveness. So much depends upon the design and arrangement of the jets and the condition in which they are kept, that a general statement relative to their effectiveness might be misleading. The same is, in large measure, true of mixing structures in the combustion chamber. The number of possible arrangements of such fixtures is infinite and, in fact, the number of arrangements that may successfully be applied to any particular set of conditions is probably large. The only statement of a general nature relative to these mixing structures that the author is inclined to make, is that their effectiveness seems to depend largely upon the sudden changing of the direction of flow of the gases and not upon breaking them up into streams of small cross-section.

The curves under discussion also illustrate the effect of a difference in method of operation upon the rate of distillation in this furnace. From them it is seen that by the use of one method it was possible to keep the distillation below the critical rate the most of the time. Further improvement means the changing of the form of the curves so that some of the volatile products now distilled at an excessive rate may be driven off more slowly. The exposure of any water-cooled surfaces to the radiant heat from the fuel bed tends to keep down the temperature of the furnace and of the fuel bed, and hence it lowers the rate of distillation. An increase in the frequency of firing by the spreading method will decrease the duration of smoke emission after each charging of coal and may decrease somewhat the area above the critical rate line and below the rate of distillation curve, but the variation in the rate must still be large under these firing conditions.

Inspection of the curve for the other method of firing shows that it is when the partially coked coal is pushed back that the excessive distillation occurs; but if the freshly charged coal could be more rapidly and more thoroughly heated, the curve representing the rate of distillation of this part of the volatile matter would be raised. In this way the proportion of the volatile products distilled at a rate below the critical rate would be increased and the variation in rate of distillation decreased. It is quite possible that a change in the construction of the brickwork at the front end of the furnace, so as to reflect more of the heat from the rear part of the fuel bed onto the green coal in the front, would make possible the accomplishment of the object stated.

FOR COST of transmission lines of a 2200-v., 60-cycle system, The Electric Journal gives the following figures: Underground ducts with manholes 300 ft. apart, $150 each, and junction boxes at 120-ft. intervals, $75 each; ducts laid 6 ft. below the surface in concrete, no rock excavation; for 4-duct subway, suited for residential districts, cost per linear foot of subway, excavating $1, ducts $0.20, laying ducts $0.50, repairing $0.33, manhole and junction boxes $1; total, $3.03. For 8-duct subway, as proper where a street will carry transmission lines: cost per linear foot is, excavating $1, ducts $0.40, laying ducts $0.65, repairing $0.33, manhole and junctions, $1; total, $3.38. The cost of each underground cable and installation will be about $0.32 per linear foot. For overhead construction, with 35-ft. poles, set 100 ft. apart, would be $7.50 for a pole, $1 for a crossarm, $0.30 for pins and insulators, $6.80 for hauling and setting, or $15.60 per pole, which would be $0.156 per foot of line. No. 6 weatherproof wire, with copper at 18 cents a pound, will cost 1.44 cents per foot, and 0.8 cent a foot for stringing, or 2.24 cents per foot of conductor in place. The cost per foot of line would then be $0.0224 \times 2 + \$0.156 = \$0.2004$.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Induction Motors

CHARACTERISTICS AND SIMPLICITY MAKE THESE MOTORS POPULAR; CARE NEEDED AND METHODS OF IDENTIFYING TROUBLES. BY T. H. REARDON

THE plain 2-phase induction motor, with its sturdy construction and operating characteristics approaching invulnerability, has by merit peculiar to itself laid claim to the most important zone in the field of individual drive.

Absence of a commutator, freedom from brush troubles, absence of a complicated armature winding and many other features of note have given the induction motor a degree of prominence in the electrical field which reflects credit upon its construction and at the same time affords evidence of the highest satisfaction on the part of its users.

Notwithstanding all that can be said in favor of the induction motor, it should be borne in mind that no piece of mechanical or electrical apparatus is absolutely foolproof or entirely immune from hazards of a mechanical or an electrical nature. It therefore behooves the users of such motors to educate their employes who are connected with either the operation or

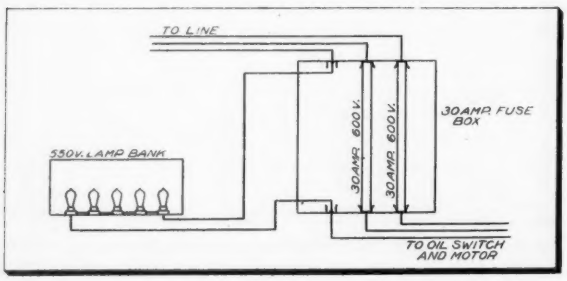


FIG. 1. USE OF LAMP BANK FOR DETECTING AN OPEN CIRCUIT

repairs of such motors, to such an extent and in such a manner that injuries to motors will be rare and that when an injury does occur, a substantial repair may be made with the least expenditure of time, energy and material.

As to general care in operation, the manufacturers' printed rules furnished with motors will, if followed, suffice for every need, and it is not the writer's intention to furnish any supplementary detail thereto.

It is when trouble develops that the following advice and suggestions are to be specifically applied, and in the order given for the purpose of securing the maximum in results with the minimum expenditure of time and energy.

It must be borne in mind that when a machine or a line of machines is down, it is not alone the repairman's time that is being wasted, for at the same time production is held up and the cost of delay depends upon a host of factors that are beyond the scope of this article.

Before taking up the diagnosis of motor troubles in regular order, a few words in regard to the proper fusing of electrical apparatus will not be out of order.

Some people believe in fusing apparatus rather heavy, as this is one way to avoid interruption to service.

It is true that interruption may be a greater evil than that which follows as a sequence to over-fusing, but the writer is inclined to the view that the elimination of 2 evils is vastly superior to the elimination of the greater and the retention of the less.

If motors are fused only slightly above their rated amperage, it is imperatively necessary to have a man close at hand to replace fuses when they blow.

Such a man should be employed in some other capacity, and be available and competent as an electrical fuse man, when needed.

The first step in motor examination should be to open the fuse box door, fasten it up some way and test the fuses with a lamp bank. A lamp bank for 550-volt work can be made by taking 5 110-volt lamps of the carbon incandescent, 30-watt, 8-cp. variety, arranging them in series and placing the whole in a convenient receptacle that will fit in the coat pocket, thus being always at hand when needed. By placing the terminals of the lamp bank leads against the contacts in the top of the fuse box, the lamps will burn normal between outside and neutral (2-phase, 550-volt, 3-wire system) and at intense brilliancy between the outside wires, 778 volts being the potential across the outside wires.

The test at the bottom of the box should give the same result if fuses are not blown.

If a fuse is blown, the application of the lamp bank at the top and bottom of the box will readily show which one it is.

If at the top of the box a light is not obtained between 2 particular contacts, it indicates that the trouble is farther back in that direction—probably at the next cutout, and must be traced back.

If fuses are good at the bottom of the box (bottom assumed to be next in order to the oil switch), remove an outside fuse with the fiber pliers and bridge the gap made with the lamp bank, the switch to the motor being closed, when, if that particular phase winding is not open, the lamps will light up.

Try the lamp bank the same way by removing the other outside fuse and bridging the gap and finally removing the neutral fuse and bridging if necessary.

The method of using the lamp bank in this particular manner is illustrated in Fig. 1, and the object of the test is to locate open phases either in the motor itself or in the connections between the fuse box and the motor.

If an open is found, remove all fuses from fuse box and make leads bare where they enter motor; a very small, bare spot on each will be sufficient, being careful to keep leads separate and avoid short circuits; restore fuses in fuse box and apply lamp bank to bare spots on leads near motor, when, if illumination is obtained upon making the different contacts, it shows that the current is O. K. up to the point tested, and that the trouble is inside of the motor.

If a light is not obtained, the trouble is between motor and the fuse box, perhaps in the oil switch, either loose wire contacts or loose finger contacts.

In what immediately precedes, it is understood that the power is to be thrown on the motor when getting these indications, as with the switch open, no result would be obtained.

The circuit may be grounded in the apparatus, in the oil switch or in the motor.

Try the lamp bank between a live contact, in the fuse box and a positive ground to ascertain if there is any appreciable leakage from line to earth; if so, this source of current can be used for testing out grounded winding.

Remove all fuses from fuse box, close motor switch and bridge from top to bottom, different contacts in fuse box, if the circuit is in contact with iron framework of switch or motor, current will go to earth and lamps will show more or less illumination, depending upon the amount of leakage that takes place through the earth circuit.

Obtaining this indication, proves that either the oil switch wiring or the motor winding is grounded; but the failure to get this indication does not prove that grounding is absent, for, as pointed out above, the line insulation may be so excellent that one positive ground will not give any current flow, as 2 grounds are always necessary for the completion of a circuit.

With 2 lamp banks (a double-pole lamp bank), current from the fuse box could be used to test out; but it would undoubtedly be better to use a small transformer ratio one to one, as otherwise the results secured in making ground tests of windings may be entirely misleading if wrongly interpreted.

Open phases within the motor may be repaired on the spot, if easily located and accessible; but often it is more expeditious to have motor taken to a shop.

The motor bearings are second in order in the location of trouble; they should never be overlooked, but it is a well established custom to allow electrical features to take precedence in making examinations for the purpose of locating trouble, electrical strains asserting themselves with far more suddenness than the corresponding mechanical strains.

Worn bearings are frequently responsible for a whole lot of trouble and where there is any considerable elevation of temperature above normal the bearings should be examined at once.

Rise of temperature in a motor is nearly always referred to overload with a correspondingly large current.

When the bearings are worn to such an extent that the rotor rubs the stator, there is a large amount of heat generated purely by mechanical friction, i. e., the revolving element rubbing against the fixed element, and there is the further effect of slowing down the rotor far below synchronous speed which again causes more current to flow.

The writer has seen motors that heated up and even smoked, operate entirely satisfactorily after new bearings were inserted.

Wear in the bearings in the case of small and medium sized motors can generally be detected by taking hold of the pulley or gear and exerting pressure both horizontally and vertically, when if any perceptible movement occurs it indicates lost motion in the bearings. Care must be taken to eliminate belt and gear tension in

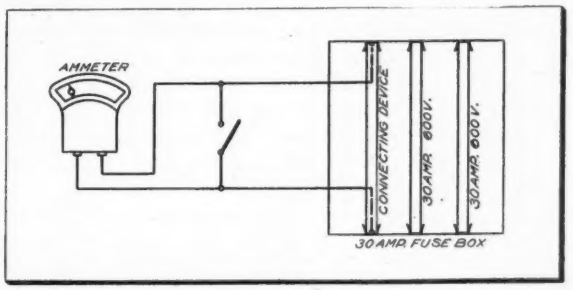


FIG. 2. AMMETER CONNECTIONS TO INDICATE A SHORT CIRCUIT

making this test; if this is not done, the wear in the bearings may not be perceptible.

To ascertain the clearance between rotor and stator, a thin, flat piece of steel about 0.01 in. thick passed between rotor and stator all the way around will show whether clearance exists at all points.

When the rotor is removed for any purpose whatever, it should be given a careful examination to ascertain whether the rotor conductors and the end rings are electrically intact, i. e., well connected either by solder or electrical welding, for if not so the torque will be small and the operation poor.

If the motor heats up badly and the trouble cannot be referred to anything revealed by the tests made up to this point, an overload or short-circuited phase windings may be the cause of the trouble and an ammeter should be cut into each phase and the amperage that the motor is drawing should be ascertained. An ammeter can most conveniently be inserted in the phase by removing successively each outside fuse in the fuse box and bridging the gap made with the ammeter.

The writer has devised a scheme for making this connection that is extremely simple and works satisfac-

torily; it is as follows: Take a fiber shell that has been in use as a cartridge fuse, and of the size most generally used.

Remove the contents of the shell, retaining the brass caps on each end.

Drill a hole one inch from each end large enough to admit, say, a No. 14 B. & S. rubber covered cable, insulation 3/64 in. thick.

Solder this wire to the brass cap, one lead to the top cap the other lead to the bottom cap, and bring wires out through holes in the fiber shell for ammeter leads.

Connect leads to ammeter, remove a fuse from the fuse box and insert the ammeter connecting shell in the place of the fuse that has been withdrawn, the motor being stopped, of course, while the connection is being made.

If the large starting current that the motor takes is liable to injure the ammeter, a small switch can be placed in the ammeter circuit that will short-circuit the leads until the motor comes up to speed, when the ammeter can then be included in the circuit and will indicate the current that the motor draws when running at normal speed.

It will generally happen that the current in each phase will be the same, but if one phase winding is short-circuited, the impedance in that phase will be less and the ammeter will give a high reading.

Figure 2 shows the arrangement for placing the ammeter in the circuit; by slightly modifying the scheme, it will be readily apparent that temporary connections, both series and mulitple, for power purposes, can be made with similar fuse box connections.

Every step in such work should be logical and should be suggested by the previous step and the work of making repairs, creditable as it may be, should be supplanted by the higher ideal, that repairs at best are but a necessary evil and when high grade apparatus receives the intelligent care that it deserves, repairs will be the exception and not the rule.

Practical Electrical Engineering

TRANSFORMER DETAILS; CORES, COILS, CONNECTIONS, CASES, COOLING AND TERMINALS. BY NORMAN G. MEADE

TRANSFORMERS are manufactured in several classes, each class being designed for its particular service; the chart, Fig. 1, classifies the types and ratings. Air-blast transformers employ the shell form of construction and are built by leading manufacturers for any capacity from 100 kva. upward, for all frequencies, and for any voltage up to 33,000.

Air-blast transformers for voltages above 33,000 are impracticable on account of the space required for installation. About 150 cu. ft. of air per minute are required for each kilowatt of loss in the transformer, at pressures from ½ to 1 oz. per sq. in.

Oil-insulated, water-cooled transformers are built for any capacity from 100 kva. upward, and for any frequency and voltage. They are constructed in core and shell types, depending on the capacity and voltage. Welded boiler-iron cases are generally employed, which are fitted with cast-iron covers provided with manholes.

Cooling coils are made of seamless brass and are subjected to a pressure test before placing in the tank. Approximately ¼ gal. of water a minute is required for each kilowatt loss.

Oil-insulated, self-cooled transformers are of the shell or core type, as determined by capacity and voltage. They are designed for capacities up to approximately 750 kva., and are mounted in corrugated sheet-iron cases having the top and bottom cast on. The cases are fitted with cast-iron covers. Above this size and up to 3000 kva., the cases are of the tubular type, made of boiler iron and have boiler tubes welded in to provide surface for radiation.

Distributing transformers are generally available in capacities of from ½ to 100 kva. in a number of styles for various voltages up to 16,500 volts. Distributing transformers adapted for use in manholes and 3-phase transformers are also manufactured. The advantage of 3-phase transformers over 3 single-phase transformers having an equivalent combined capacity are: Smaller floor space, lighter weight, higher efficiency, simpler installation and lower cost. The disadvantages are: Greater cost of spare units, greater cost of repairs, greater derangement of service in case of breakdown and difficulty of bringing out taps for a large number of voltages.

Standard voltage ratings for transformers are 2200, 6600, 11,000, 16,500, 22,000, 33,000, 44,000, 55,000, 66,000, 77,000, 88,000, 100,000 and 110,000 volts. Standard frequencies are 25 and 60 cycles.

SPECIAL TYPES OF TRANSFORMERS

SEVERAL TYPES of transformers for special service are built, including, constant current regulating, instrument, sign lighting and bell ringing, welding, pipe thawing and electric furnace. With the exception of the constant current regulating transformer, the other types embody the same principles as the regular transformer. In addition to the special types mentioned, there are auto-transformers, voltage regulating transformers and induction regulators.

The advantages derived from the use of constant current regulating transformers will be apparent when it is realized that the operation of low-voltage arc lamps in parallel on a constant potential system necessitates a prohibitive expenditure for conducting material when the area to be lighted is extensive and the lamps widely separated. For such service it is the common practice to operate the lamps in series with a constant current.

The constant current transformer is a special form of apparatus which converts alternating current at a constant potential of any value to a constant (alternating) current with a voltage varying with the load. It consists essentially of a primary coil upon which the constant voltage is impressed, a secondary coil, or coils,

movable with respect to the primary, and a core with appreciable magnetic reluctance. It depends for its regulation upon the magnetic leakage between the primary and the secondary coils.

Transformer Characteristics

Direct current has given way largely to alternating current for transmission, and this is due largely to the ease with which the latter may be transmitted over long lines at high voltages and transformed to current of lower voltages at the receiving end. If electric power is transmitted over long distances, in order to reduce transmission losses and the cost of copper, it is necessary to use a high voltage.

Air blast	Type -- Shell Capacity, 100 Kva. upward Voltage, up to 33,000 Single phase
Oil-insulated water-cooled	Type -- Shell and Core Capacity, 100 Kva. upward Voltage, up to 110,000 Single phase
Oil-insulated self-cooling	Type -- Shell and Core Capacity, 3,000 Kva. Maximum Voltage, up to 110,000 Single phase
Distributing	Type -- Shell and Core Capacity, 1/2 to 100 Kva. Voltage, up to 16,500 Single and 3-phase
Constant-current regulating	
Instrument	Current Potential
Sign Lighting	
Bell Ringing	
Welding	
Pipe Thawing	
Electric Furnace	
Auto Transformers	Type -- Core Capacity, unlimited Voltage, limited to about 1 - 2 or 2 - 1 ratios of transformation 1, 2 and 3 phase
Voltage regulating	
Induction regulators	

FIG. 1. CLASSIFICATION OF TRANSFORMERS

Line losses increase with the square of the current; consequently if the electromotive force on a line is doubled, for a given loss the size of the conductors are reduced 75 per cent.

Transformers may be used to increase the voltage from a low to a high value for transmission purposes and for reducing the voltage from a high to a low value for distribution. In the former case they are known as step-up transformers and in the latter case as step-down transformers. With any change in voltage, either an increase or decrease, there is a corresponding change in current. Assume that a current of 20 amp. is supplied to a transformer from 1000-volt mains; with a noninductive load connected to the secondary the current and voltage would be practically in phase and the watts supplied to the primary side would be $20 \times 1000 = 20{,}000$. Neglecting losses there would be delivered 20,000 watts from the secondary and the secondary current would be 200 amp. if the secondary voltage was 100.

There is always some loss in a transformer, therefore the watts output divided by watts input gives the efficiency of the transformer. A well constructed transformer is highly efficient, in large sizes the efficiency often being greater than 98 per cent.

Transformers of the stationary type for changing alternating current from one voltage to another, are frequently called static transformers to distinguish them from rotary converters and other forms of transforming apparatus.

Figure 2 shows a simple transformer consisting of a primary coil, P, and a secondary coil, S, interlinking an iron magnetic circuit. The line electromotive force E, sets up a current in the primary coil which creates an alternating flux in the iron cores and keepers. This in turn sets up a counter-electromotive force in the primary coil P, which, if there were no resistance in the winding, would be equal and opposite to the impressed electromotive force, E. The current which will flow, therefore, in the primary winding, when the secondary winding is open, is that which is required to set up the magnetic flux capable of producing the counter electromotive force.

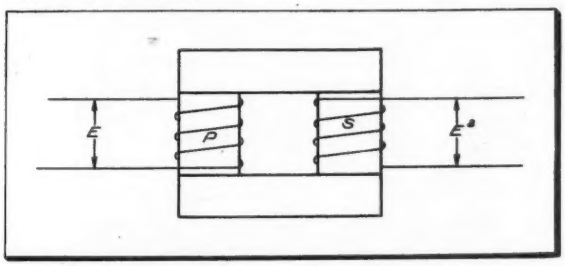


FIG. 2. DIAGRAM ILLUSTRATING PRINCIPLE OF TRANSFORMERS

Flux set up by the primary coil also interlinks the secondary coil and is continually altering through it, therefore an electromotive force, E^2, will be set up in the latter coil, equal to the continued product of 4.44, the number of lines of force, number of turns of wire on the secondary coil, and the frequency divided by 10^8 or 100,000,000. Expressed as a formula,

$$E^2 = \frac{4.44 \times N \times Ts \times n}{10^8}, \text{ in which}$$

N = Magnetic flux,
Ts = Turns of wire in secondary coil,
n = Frequency in cycles per second.

The ratio of the primary to the secondary voltage, $E : E^2$, is called the ratio of transformation and is equal to the primary turns divided by the secondary turns. As an example, if a transformer has an impressed primary electromotive force of 1000 volts, and if the primary coil has 500 turns and the secondary 50 turns, the ratio of transformations is 10 and the secondary voltage

$$1000 \times \frac{50}{500} = 100 \text{ volts.}$$

(To be continued.)

A New 3-Wire Commutating-Pole Type Dynamo

RECENTLY, the General Electric Co. has placed on the market a new line of engine type direct-current generators, in a complete line of standard sizes ranging from 25 to 400 kw., for both 2-wire and 3-wire service, with either shunt or compound field winding, and wound to deliver the rated capacity at any voltage from 115 to 125, or 230 to 250. Sizes larger than 400 kw. capacity are built on specification.

These generators are designed for speeds conformed to the best modern engine practice, after careful conference with the leading engine builders, and compound wound machines, automatically compensate for line drop in the distribution system, any degree of compounding desired being furnished, although 4 to 5 per cent is usually sufficient for average conditions. The frame is designed for installation on the engine bed plate, or on masonry foundations, and the armature bored for mounting on the engine shaft.

THREE-WIRE COMMUTATING POLE TYPE, G. E. DYNAMO

Commutating poles, which are one of the distinctive features of this design, permit of operation over a wide range of load and voltage with the brushes in fixed position and sparkless commutation. This is accomplished by a commutating field, produced by windings on interpoles, which nullifies the armature reaction and generates an electromotive force, that helps the brushes to commutate the current in a natural neutral without sparking. These commutating windings are in series with the armature winding, so that their strength varies directly with the armature current, and makes it unnecessary to shift the brushes as the load changes.

In the development of the 3-wire feature of these machines, a special type of revolving compensator is used, having one collector ring for making the neutral connection of the 3-wire system. This compensator consists of a circular magnetic core upon which are mounted suitable exciting coils, the core and coils being assembled on a cast bracket, bolted directly to the back end of the armature spider. The compensator fits under the overhanging end windings of the armature, projecting but a short distance beyond the main winding and requiring no additional allowance in floor space. The windings are connected to the main armature winding at proper points, with the neutral connection taken through the armature spider to a single collector ring mounted on the outer end of the commutator shell. The neutral brushes, which bear on this ring, are supported from the main brush holder studs, but insulated from them.

Advantages of the 3-wire system of distribution are well understood, since a 125-250-volt system requires about ⅓ the amount of copper needed for a 125-volt, 2-wire system.

Aside from the armature construction, the important difference between the 2-wire and 3-wire form of generator is in the field connections. In the 3-wire generator, the series and commutating fields are equally divided between the 2 sides, positive and negative, of the armature, insuring exact compounding for all the load conditions, whether balanced or unbalanced. Generators of this design are arranged to carry an unbalanced current of 25 per cent of the rated full load in the neutral wire. Ventilation is secured by the use of armature cores, windings, spiders and flanges, commutator shells and field coils of open construction, which permit of a free circulation of air.

A cast steel magnet frame, split horizontally above the center line, is used, so that the generator can be taken apart for cleaning, inspection or repair, without removing any of the steel poles. The poles are of laminated steel, punched to suit the finished frame, and held in place by bolts; the commutating poles are of rolled steel, held in place by bolts, and carrying a helical winding of edgewise-wound copper strip. On the main poles, the series coil is mounted outside the shunt coil, separated to permit thorough ventilation, and the shunt coil is thoroughly insulated on a sheet metal body, supported by heavy insulating collars. This construction permits either main or commutating poles, with their coils, to be removed readily without interfering with the magnet frame or brush rigging.

In the armature winding, which is either multiple or series, as best suits the design, an improved wrapped type of insulation is used, formed from bar stock in coils of endless type, and held in the slots by hard wood wedges, dovetailed in the punchings, with binding bands on the ends, but not extending over the core. The end connections of coils are supported by flanges bolted to the armature spider, and suitable equalizer connections are provided on multiple wound armatures, to prevent any difference in voltage, due to variation in the air gap, and also to equalize the magnetic pull on the shaft.

In the commutator, the mica insulation between segments is carefully gaged to uniform thickness and is made of such hardness as to wear evenly with the copper. The segments are sufficiently long to permit staggering the brushes, thus insuring even wear of the commutator surface. Connections to the armature winding from the segments are made by copper strips soldered into the segment and to the conductor.

A groove is turned in the magnet frame, into which the brush holder yoke fits closely, with the brackets firmly attached to it and made adjustable to allow for the natural wear of the commutator. The brush holder

studs are riveted in the brackets, and the whole rigging is so arranged that after the brushes are once adjusted in their proper position, the yoke is locked in place and no shifting is required. The brush holder body is a single brass casting, with long bearing surface, which eliminates grooving of the brush and with a metal cap riveted to the brush, against which the steel lever is forced by a steel wire spring; a flexible copper connection is supplied for keeping current out of the brush holder spring.

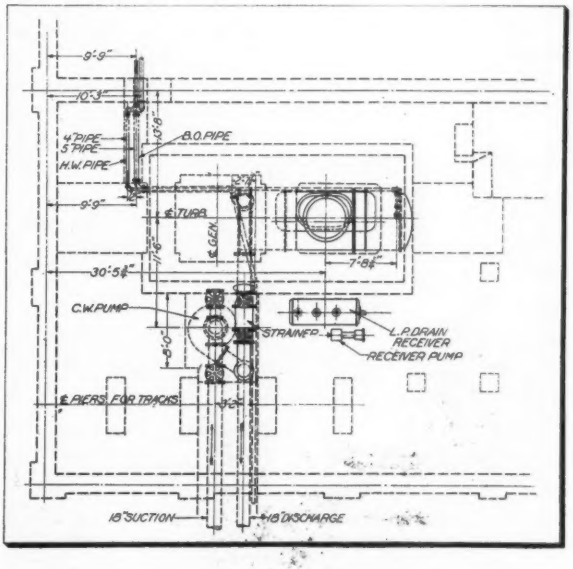
The special features of commutating pole, thorough ventilation, fixed brush position, security brush rigging design, and ample commutator surface, make these machines particularly well adapted for satisfactory and reliable operation under severe service conditions, where the load fluctuates widely and frequently.

Power Without Labor

(Continued from page 436.)

Ample room has been allowed above the economizers for repair and replacement, as may be necessary, and for the installation of the machinery operating the scrapers. This machinery is of the regular type, furnished by the Green Fuel Economizer Co., and is driven by a Westinghouse induction motor belted to the economizer shaft.

Control of the gas passages is by means of hand-operated dampers of Louver type, except the cross-connecting damper between the economizers and the one which passes direct to the stack. These are vertical trap dampers, raised by chains passing over sprocket wheels.



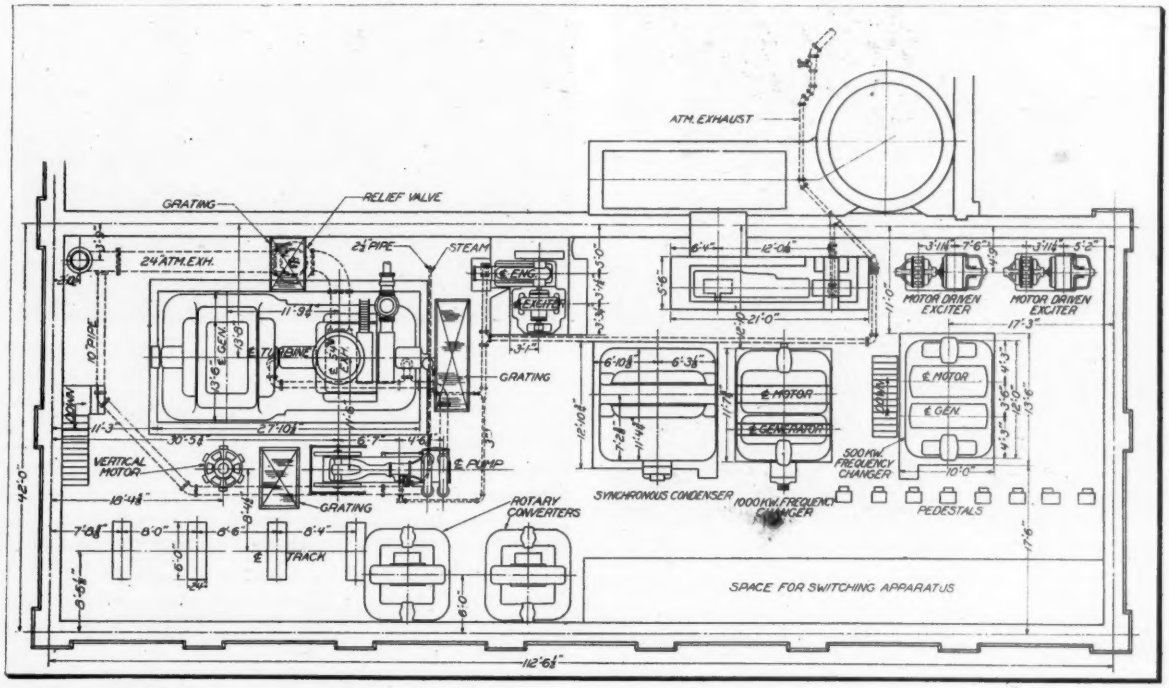


FIG. 7A. PLANS OF TURBINE ROOM AND OF BASEMENT

The engine driving the induced draft fan is located in the generator room, with the shaft projecting through into the fan chamber. Steam is supplied from the engine steam main, and the exhaust is into the atmospheric exhaust main, which discharges to a vertical riser leading to the feed-water heater, and with a relief valve to the atmosphere through the roof.

Turbine Equipment

In the generator room is located the only generating unit of the station, a Curtis 5000-kw., horizontal type, running at 1500 r.p.m., and generating at 13,200 volts, with a frequency of 25. It is to take steam at 175 lb., and is rated for a power factor of 0.8. Attached to the

base is a Dean Bros. oil pump, 5½ by 3¾ by 5 in., duplex, for circulating the lubricating oil through the bearings. Steam is brought to the turbine through a Schutte & Koerting valve, and exhausts into the Alberger Spiroflo condenser, which is located directly beneath the turbine. This is of the construction shown in the issue of January 15, page 181, except that the exhaust steam inlet is at the top and the condensate is drawn from the bottom.

The dry vacuum pump, connected to the top of the condenser, is of the Alberger reciprocating type, and discharges to a pipe in the basement, connecting with the atmospheric emergency exhaust from the turbine. A

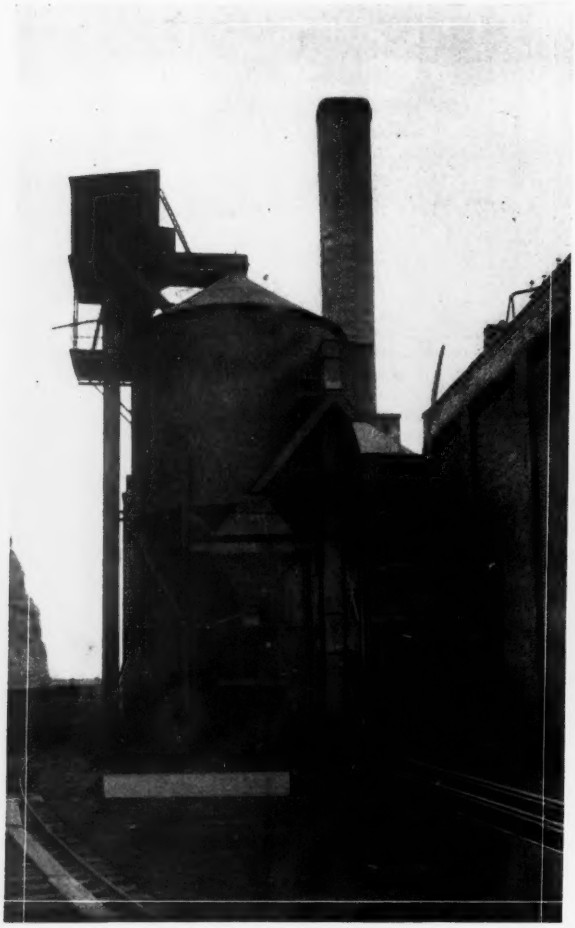


FIG. 8. THE COAL STORAGE AND ELEVATORS, AND ASH-CONVEYING SYSTEM

cross connection is made from the suction of the dry vacuum pump to the top of the water chamber in the condenser, so that vacuum may be established, when starting up the unit, to draw water from the river and thus prime the centrifugal circulating pump.

This 9000-gal. circulating pump is located in the basement and driven through a vertical shaft by a vertical interpole motor made by the Electro Dynamic Co., of Bayonne, N. J., which is placed near the dry vacuum pump in the turbine room. The motor is driven at 350 to 700 r.p.m., according to the amount of cooling water needed, and is of 100 hp. capacity, at 250 volts.

The pipe which takes the water from the river for cooling the condenser is 18 in. in diameter, the pump being located between the river and the condenser. Water passes from the pump to the condenser through a Liberty twin strainer to prevent the entrance of any sediment to the condenser shell, and leaves the bottom of the condenser and is carried by gravity back to the river. Thus a siphon effect is produced, and the only work that the pump has to do is the overcoming of friction in the system.

In arranging the inlet for this system, an experiment was tried by using the end of a section of 18-in. pipe, capped and drilled with holes some 2 in. in diameter, without an inlet well or other strainer. This was laid directly on the bottom of the river, and led away into a trench where it was buried to prevent side motion. Some debris came through the pipe at first, but after a little the scouring action of the inflow cleared away an open space around the end of the pipe, and no further trouble is experienced with sand or refuse.

The dry vacuum pump has tandem arrangement of the cylinders, with flywheel and cutoff valves, and with

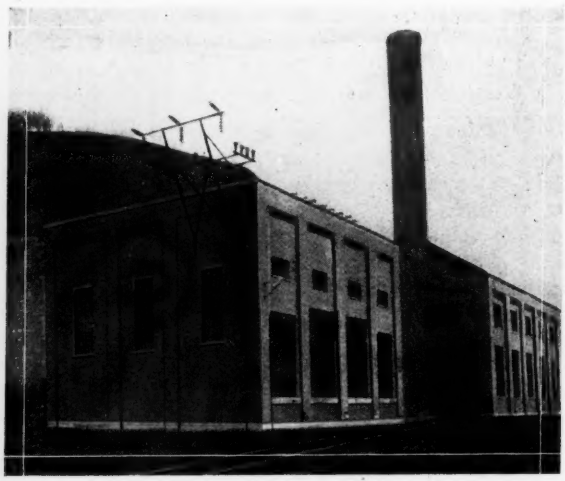


FIG. 9. VIEW OF SUBSTATION AND MAIN PLANT

cylinders 12 by 30 by 18 in. This unit and others not having ring oiling bearings in the plant, are lubricated from a gravity system, the supply coming from an overhead tank and the discharge going to an installation of Burt filters located in the basement, from which, after purification, the oil is drawn by a pair of Canton-Hughes duplex pumps 3 by 2 by 3 in., which return the oil to the overhead tank. Cylinder and engine oil for hand feed are kept in a Bowser system of pump tanks near the boiler-room door.

Exciting current is supplied to the turbine generator at 250 volts. It comes from either one of 2 units. The engine driven unit, located near the turbine, consists of a Skinner, 11 by 12-in., simple engine, direct connected to a General Electric interpole type generator, having a capacity of 300 amp., and running at 275 r.p.m. The interpole system, with the series windings, provides a unit which can run sparklessly at any load without shifting of brushes, and thus reduces the care of this unit to practically zero.

The other exciting unit is motor driven, located beyond the fan engine, and consists of a 115-hp. induction motor, taking current at 250 volts, 25 cycles, and running at 715 to 750 r.p.m., according to the load carried. The generator end consists of a General Electric dynamo of 75-kw. capacity, delivering at either 125 or 250 volts, as may be desired for excitation of the different a.c. units in the plant.

mounted above. Current at 13,200 volts is taken from the turbine through a control and out to the transformers in the substation. It is here stepped up to 66,000 volts, and carried out past the lightning arrester connections to the main transmission line, which will pass on to East St. Louis. Until such time as the line is completed for the 66,000-volt transmission, current coming from Keokuk goes from the 13,200-volt side of the transformers,

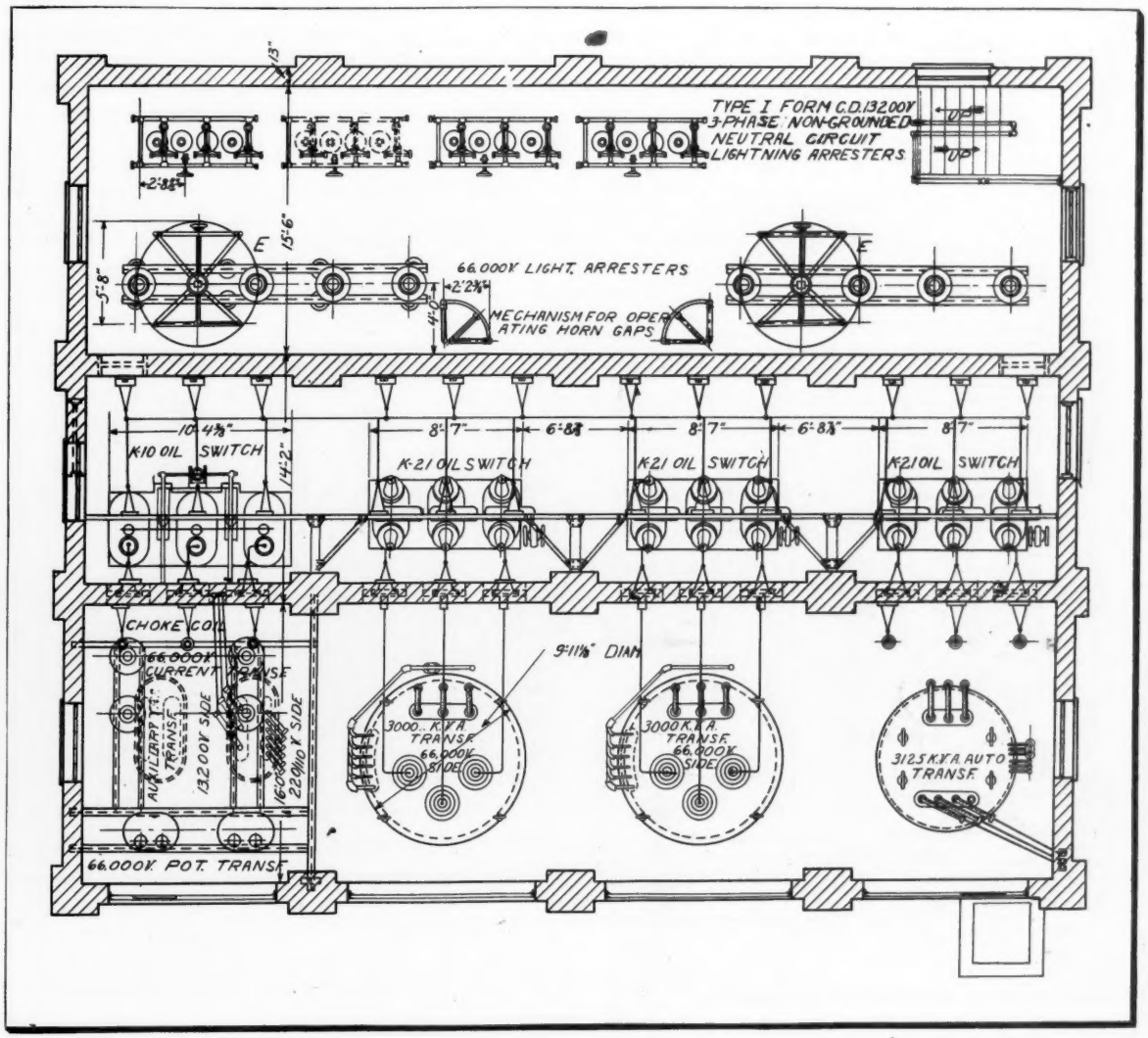


FIG. 10. PLAN OF SUBSTATION

Electrical Control

For the handling of high-tension current on the 66,000 and 13,200-volt lines, the switches are located in the substation and operated by remote control, current for the motors being furnished by a storage battery located in the basement of the generator room. The switches and instruments for this control are mounted on pedestals in the generator room, each circuit or machine having its own pedestal.

Wiring comes from the basement through conduits into the bases of the pedestal, and the instruments are

in parallel with the turbine, direct to the line which transmits to Granite City and East St. Louis.

This current is 25-cycle, and for use in the City of Alton, it is necessary to have 2300-volt, 60-cycle current for commercial work, which is secured by the use of a motor generator of 500 kw. capacity on the generator side, running at 300 r.p.m., the motor side being a 710-hp., 3-phase induction motor, taking current at 13,200 volts, 25 cycles.

A second motor generator set is to be installed, with capacity of 1000 kw. These units take exciting current at 125 volts, and deliver their current to a panel switch-

board located under the gallery, which handles the 2300-volt alternating current, the connections for the exciter units, and the connections for the city arc lights. This panel board will also include, later on, a switching system for the street railway current, which will be furnished by rotary converters in the plant.

In order to keep up the power factor on the system, a synchronous condenser of 1500 k.v.a. capacity is installed, running on the 13,200-volt line at a speed of 375 r.p.m. It operates by varying its field excitation simply to correct for lagging current, and is arranged under the usual conditions of the plant, to throw into the line sufficient leading current to neutralize the induction effect of the motor load and the transmission lines.

On the pedestals which control the lines, 3 ammeters are mounted, so that any unbalancing may be detected at once. On a machine control pedestal is mounted an ammeter with a 3-way switch, so that it can be thrown into any one of the 3 phases, a wattless-current indicator to show what capacity is being wasted from lagging current, a voltmeter with plug switch to throw it onto any pair of terminals, and the necessary control switches for operating the remote control mechanism.

On all oil circuit breaking switches, time limit relays are used, so that an instantaneous short will not produce opening of the line, but a short which continues long enough to be dangerous will cause the circuit to open.

On the pedestal for the turbine there is provided a

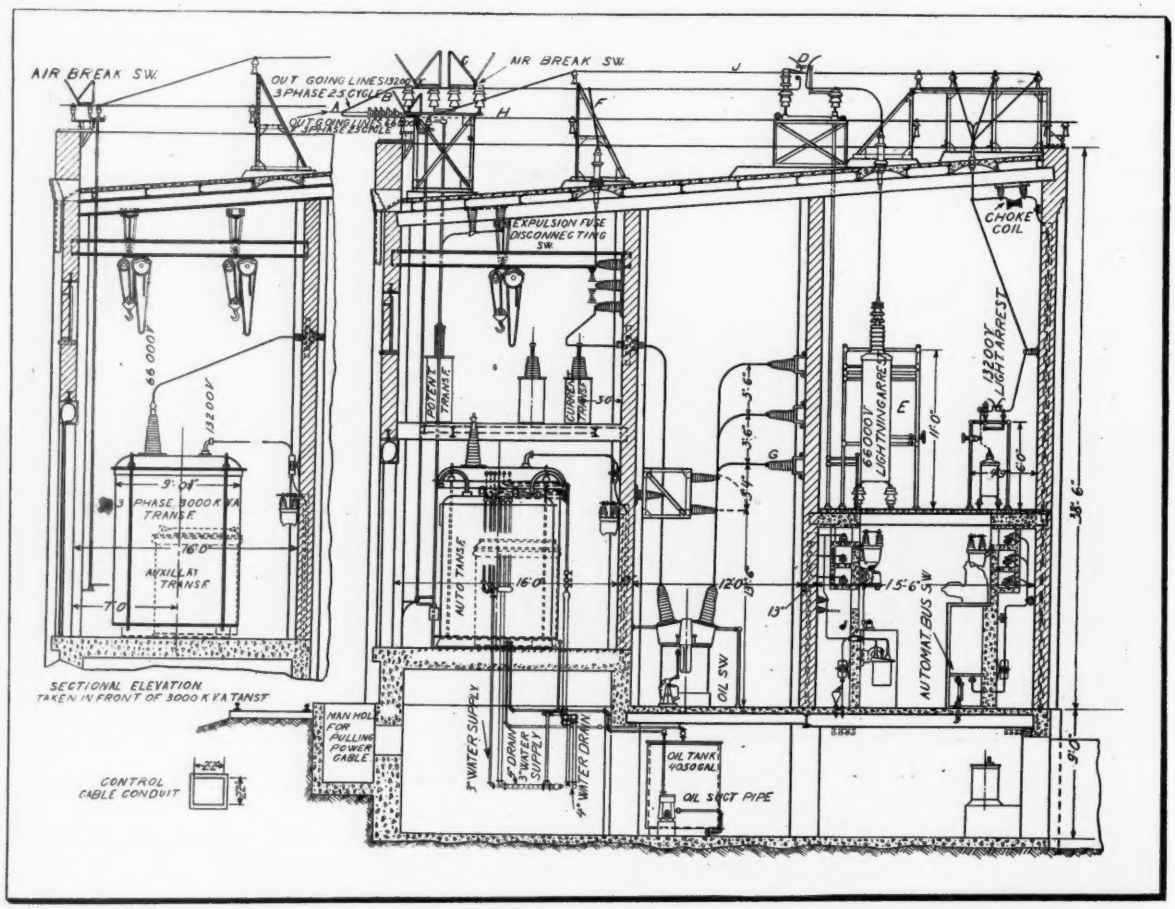


FIG. 11. SECTION THROUGH SUBSTATION

Lead covered cable is used throughout the station for making high tension connections, and is carried from the station to the terminal house and to the substation in underground conduit, either placed on the basement floor or made into groups and racked against the basement ceiling.

The pedestal controls are 8 in number, one for the 66,000-volt line switch, one for the 2 large transformers, one for the frequency changers, one for a bus tie switch, one for the East St. Louis tie line, one for a future line to be installed when needed, one for the turbine, and one for the synchronous condenser.

switch for connecting it to either of 2 bus lines, a 3-way ammeter switch, control switch for the rheostat, and along the base of the pedestal, a series of indicating lights, showing exactly the position of the field rheostat control at all times. A swinging post at the end of the row of pedestals carries the synchroscope, 2 voltmeters and a frequency indicator, these voltmeters being connected to any line or machine by means of plug switches on the various pedestals.

In the final arrangement of the plant, all mains for Alton supply will be carried to a terminal building beyond the substation, underground, will there rise and be

carried out through the 4 sides of the building, the railway feeders on one side, arc circuits on another and 2300-volt commercial circuits on the other 2 sides. These mains will be carried up the sides of a 50-ft. steel tower to be built around the terminal building, and then led to the top of the bluff, where a substantial steel terminal tower will carry the upper ends. All distributing mains for the city will be carried out on the same poles, and led off according to service requirements.

On the panels under the balcony the exciter control is located, the buses being arranged on the 3-wire system to care for the 250 and 125-volt excitation of different machines. Other provisions are as for standard practice for the various machines served. Panels are provided for the motor driven and engine driven exciters, voltage regulator, plant motors, storage battery, frequency changers and Alton supply, this having a 3-phase power feeder, a 3-phase lighting feeder and 3 1-phase lighting feeders for lightly loaded sections. One novel feature is the carrying of all field switches to a single panel, thus bringing together and simplifying the provision against inductive sparking when the switch is opened.

on steel framework, across the roof, with connections to the lightning arresters and through choke coils to the oil-break switches.

The 13,200-volt lines are handled in the same fashion except that a less degree of insulation is required, and the circuits are not dead ended.

The building is divided by concrete walls into 3 rooms, one for transformers, one for 66,000-volt switches, and the third for 13,200-volt switches and bus bars on the lower floor and lightning arresters above.

The transformer room has 2 3000-k.v.a. units, 66,000 to 13,200 volts, an auto transformer of 3125 k.v.a. rating for voltage control, a small transformer, 13,200 to 220 and 110 volts for station motors with space for a second unit, and above these on a steel-beam framework, the voltage and current transformers for the instruments on the 66,000-volt system. The installation is most easily understood by tracing out a circuit.

From the line, A, Fig. 11, which is dead ended by a series of insulators, the tap, B, is taken to the air break disconnecting switches, C, and on to the horn gaps, D, which connect down to arresters, E. At F a tap is taken through the roof insulator to the choke coils and the

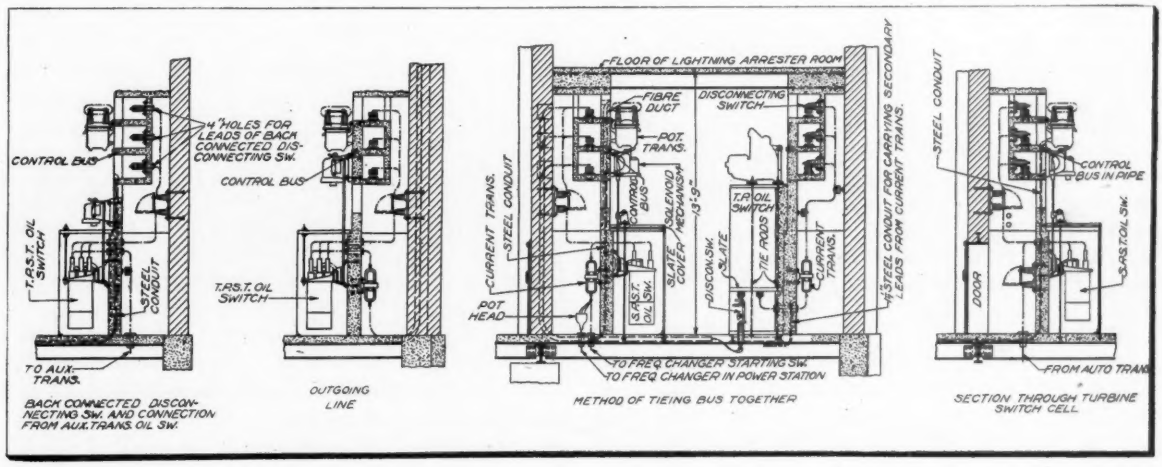


FIG. 12. CONNECTION DIAGRAMS FOR 13,200-VOLT SWITCH SYSTEM

Beyond these panels is a space reserved for future railway feeder panels and beyond the end of the balcony the foundations for the railway rotary converters and piers on which track will be carried for setting a car into the turbine room under the crane. Entrance is obtained by a large steel rolling door of the type used on all large openings to both station and substation.

On the gallery above the panel boards will be space for voltage regulators and tub transformers for the arc-circuits, and for field resistances for the different units.

Substation

EXTREME VOLTAGE of 66,000 is brought only into the substation, a concrete, brick-veneered building 61 by 49 ft., located across a 15-ft. alley from the main station. Lines are dead ended on 5-section petticoat suspension insulators anchored to the roof, and tap wires are carried on triple-petticoat, high tension insulators mounted

current transformer, then through the wall insulator to the oil switch. From this it rises through a disconnecting knife switch to the 66,000 bus wires, G. On the plan view, the connections of the present line are seen at the left hand end of the rooms, and the space for the future line at the right-hand end, opposite the autotransformer. Connections from the bus wires, G, to the transformers are through similar disconnecting and oil switches as indicated on the drawings.

For the 13,200-volt lines, the current is carried through a disconnecting switch to a wire, H, across the roof and down to the horn gaps and lightning arresters, which, in this case, are inside the 3rd room. A tap, J, is taken across to above the 3rd room and carried down to choke coils, then through conduit in the wall to the oil switch in the compartment below the arresters. The buses for the 13,200-volt system are in 2 sets, one on each side of the room, and disconnecting switches are

mounted inside the bus bar compartments. Solenoid mechanisms and oil switches are mounted on the front walls of the bus compartments and on the floor, also current and voltage transformers for instrument connections are placed in the spaces under the bus compartments, and in front, giving a compact arrangement with a maximum of convenience and safety. Connections from buses to transformers and main station machines are carried through conduit in the basement, walls and tunnel.

In the basement are 2 oil tanks, each of 4050 gal. capacity, sufficient to hold all the oil from the transformers, and with oil pump for transferring from the tanks to the transformer casings. Also the pipes enter here for bringing water from the main station for the cooling coils of the transformers, and returning it to the visible outlet overflow in the turbine room. At present, city water is used temporarily, but river water will be the permanent supply.

As items of convenience, the air break switches on the roof are arranged to be opened by rotating shafts operated from the transformer room, the horn gaps are operated from the arrester gallery, and Yale & Towne chain lifts are provided for handling covers, coils and cores in the transformer room. The switch track passes alongside the transformer room doors, which are rolling steel of a height to allow the largest transformers to be taken out readily into a car for shipment.

The concrete work was elaborate and difficult of construction, but has resulted in great compactness and convenience of arrangement. In the smaller views of the bus bar compartments are indicated the connections of different circuits to the buses. Secondaries from current and potential transformers are carried in 1¼-in. steel conduit or in pipe, and primary leads for potential transformers in 1½-in. fiber conduit.

Operation

This is reduced to a minimum of manual labor and a maximum of keeping track of performance and thinking. No coal or ashes to shovel, little oil to squirt, water traveling in a closed circuit from boiler through turbine, condenser, heater and economizer to boiler, feed regulated and make up water controlled; the running of the station will consist of keeping the stoker hoppers filled (by means of power machinery), watching to see that all is running well and studying those charts and records.

Yes, there will be charts and records. The coal is weighed; those meters check the water that goes to the boilers; there is an adequate equipment of Bristol recording instruments; listen—they record the temperatures of water from the economizer, of gases to and from the economizer, of water from the storage tank and from the heater, of steam entering the turbine, of discharge cooling water and of condensate; and the pressures of the boiler, the feed and wash water lines, the auxiliary exhaust main, the condenser. And on top of that there are indicating thermometers on the condenser and superheater, Asheroft gages on boilers and turbine board, a mercury column on the turbine exhaust, draft gages on the boiler breechings and a CO_2 recorder. While the instruments for keeping track of electrical performance are frequently complete as they are in this station, it is seldom that so ample provision is made for a record of performance of the steam end of the plant, and there should be no difficulty in determining and maintaining conditions of best efficiency.

The strongest impression one gets from the plant is compactness, simplicity and abundance of room. These have been secured by careful planning beforehand so that things fit together, each having its place, with room enough yet none wasted, and with orderly succession of apparatus, so that there is no retracing of paths, and no quarreling of piping or wiring for right of way.

The plant was designed by L. R. Lee, chief engineer of the E. W. Clark & Co. Management Corp., which built and is operating the station for the East St. Louis Light and Power Co. The construction has been in charge of K. B. Ward, resident engineer, H. H. Bailey, mechanical engineer, and G. W. McIver, Jr., electrical engineer for the allied interests to which power is furnished by the station. To the courtesy of the company and its representatives our readers are indebted for the information and illustrations of this description.

Practical Arithmetic for the Isolated Plant

Continued Proportions. By Irving Booth

I SHOULD like to add to Mr. Meade's paper (see Practical Engineer, Feb. 1, page 220), a few words about continued proportions that are of great interest to the engineer. They will save hours of figuring, or of the humiliating experience of being unable to turn in the figures asked for by the office.

We will approach the subject by considering the simple problem presented by Mr. Meade:—

"If 5 tons of coal cost $15, what will 12 tons cost?" He solves as follows:

5 : 12 :: 15 : 36. Answer, $36.

The only requirement of a proportion is that the product of the means equals the product of the extremes. We may, therefore, exchange the places of either the means or of the extremes and the proportion will still hold. We can therefore write:

5 : 15 :: 12 : 36.

Instead of setting 5 over 12, as Mr. Meade does, we set 5 over 15 and read 36 under 12 instead of under 15.

At first sight this looks like the difference between tweedledee and tweedledum; but the difference is real and of great value, as we now have a continued proportion. To illustrate:

Sunday, we burn 5 tons of coal, cost $15; Monday, we burn 12 tons; Tuesday, we burn 11½ tons; Wednesday, 14 2/3 tons, etc.

Having set the rule with 5 over 15, we proceed to read under 12, $36; under 11½, $34.50; under 14.67, $44, etc., for a week or a month from the single setting.

The example hardly shows the value of the slide rule, as it is so simple; but coal per ton with freight and handling runs into odd amounts. Consider the coal as, say, $4.27 per ton, and the consumption running into 3 figures. The slide rule solves these as easily as the simplest.

Passing from this simple illustration to the case of the expenses of an isolated plant, the bookkeeper fur-

nishes the total items, coal, oil, waste, labor, repairs, interest, depreciation, and what not, that are charged to the power department during the year. It is for the engineer to distribute these expenses.

They must first be distributed among the items of output, and these among the departments where they belong.

Thus the output of the plant is:

1. Electric lighting.
2. Electric power.
3. Steam for dyeing, driers, steaming, etc.
4. Steam for heating (during the winter months).
6. Miscellaneous (as compressed air, hot water, vacuum cleaner, etc.).

Obviously it will be a matter of some difficulty to figure where all expenses lie. Lamp renewals all go to 1; interest on generators, to 1 and 2. The slide rule divides this item proportionately to the watt-hours consumed, or to the connected capacity of each, according to your judgment. But fuel and boiler room labor evidently enter every item, and the continued proportion as above will distribute expenses according to steam consumption almost instantly.

As an illustration, let us consider how one of these items will be charged up among the departments.

Let us take item 4, Steam for heating.

Mill	Feet Pipe	First Setting	Error		Results
A	6450	$ 2880.	$ 4.40		$ 2884.40
B	8900	3980.	6.08		3986.08
C	3240	1454.	2.21		1456.21
D	11190	5020.	7.64	add 1¢	5027.65
E	4170	1870.	2.84		1872.84
F	7860	3530.	5.36		3535.36
Total	41810 ft	$ 18734.	$ 28.53		$ 18762.54

TABLE OF SLIDE RULE CALCULATIONS

We will further assume that in dividing up our expense account, we charge to Item 4, $18,762.54.

This must be divided among 8 mills. The management would hardly think of installing 8 steam meters, for they argue the mills will heat just as well without that expense. And as for how much is used in each, it is up to the engineer to find out. That is what he is paid for (and some other things besides). We now proceed to earn that portion of our pay. A fair estimate is that the amount of steam consumed is directly proportional to the amount of radiating surface.

All heating coils are 1¼-in. pipe, therefore we can distribute this item according to the lineal feet of heating pipe in each mill.

Looking this up, we find Mill A has 6450 ft. of pipe, Mill B has 8900 ft., and so on, for each mill, as set forth in the table. The total feet of pipe is 41,810.

We set the slide rule with 418 over 1876 and proceed to read: For Mill A, under 645, is 288, meaning that 6450 ft. calls for $2880. For Mill B, under 890, is 398, or 8900 ft. calls for $3980; and so on down the list as is set out in the table under the head of first setting.

Adding these together, we get a total $18,734. Subtracting the given amount ($18,762.54) we find we are short $28.54.

We divide this error proportionately by setting 418 over 2854 and reading under 89, 6.08, etc., as set down in the column headed "errors," adding this column we get $28.53, or 1 cent short. Add the 1 cent to the largest number—Mill D.

Adding the errors to the column of first settings, we get the results set down in the last column, totaling the exact amount required, giving a fair illustration of the distribution of expenses among different items. Exactly the same plan is followed in making a complete report.

A word may be added here as to the accuracy of this work. An engineer will observe that a result of 7 places of figures is obtained by a slide rule. Such an accuracy is of course absurd. But as the results are for the bookkeeper, the last penny must be accounted for, as that is the kind of accuracy demanded.

The point here maintained is that the slide rule, while saving endless figuring, is as honest and as accurate as any result that can be obtained in any other way possible to use. Whether expenses are distributed according to meters or scales or estimates, as in the example, there is a limit to their accuracy. Steam, water, watt-hour, and other meters, indicators, thermometers, etc., are limited to a commercial accuracy of about 2 per cent for continuous use. If you can't work to at least 1 per cent with a slide rule, heave it into the fire door. The fewer the operations, the less the accumulative error.

It will be noted that under the column headed Feet Pipe, the figures are carried only as far as can be read on the rule, measurements being to the nearest 10 ft.

The column headed First Setting, is the limit of accuracy. In fact, in the total $18,734, the $34 is gratuitous. It might be anything from $30 to $90. The further division of the error is not a means of greater accuracy. It is merely a meeting of a demand for a set of 7 place figures.

Since the slide rule is more accurate than the data, it is foolish to use laborious arithmetical work. The apparent accuracy thus secured is not real, as no result can be more accurate than the data on which it is based.

THE UNITED STATES CIVIL SERVICE COMMISSION announces an examination for junior civil engineer, on May 6, 1914. The salaries of these positions will range from $1200 to $1500 per annum, with necessary expenses when absent from headquarters in the discharge of official duties. Competitors will be examined in mathematics, including algebra, geometry, and trigonometry; theory and practice of railway surveying; education, training, and experience. Applicants must show in their applications that they have had at least 2 years' (24 months) practical field experience in civil engineering in railway work. At least 6 months of this experience must have been in the running of instruments. Special weight will be given to experience in charge of grading or other railway construction work. Applicants must have reached their 21st but not their 36th birthday on the date of the examination. Persons who meet the requirements and desire this examination, should at once apply for application Form 2039 to the United States Civil Service Commission, using the exact title, Junior Civil Engineer (Male).

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Examination for Second-Class Fireman

WHILE ACCOMPANYING a candidate for second-class fireman's license in Massachusetts, the writer overheard a series of questions, in substance, as follows. There was a small boiler in the room, of horizontal-tubular type, piped for a gravity heating system and for power supply. The grade of license applied for, permits the holder to operate any boiler under the engineer or fireman in direct charge, and is the lowest grade issued.

1. Having had experience with return-tubular boilers, have you at any time opened the fire door and seen bricks lying in the fire?
2. Where did they come from and what are they for?
3. Should they lap well over the rivets?
4. What seam do they cover?
5. How do you know how much water is in the boiler?

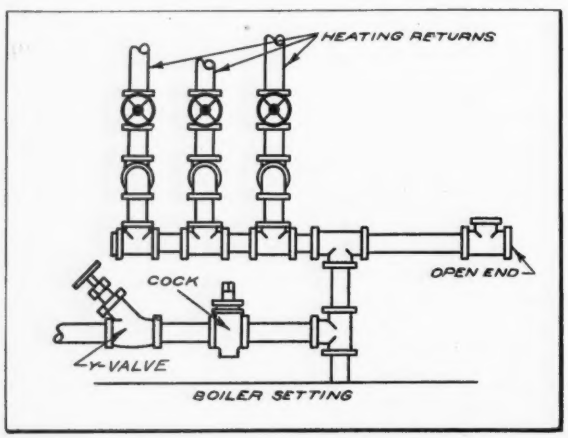


FIG. 1. PIPING TO REAR OF BOILER

6. Blow out the water glass on that boiler.

In this, the applicant left the cock at bottom of the glass open. The examiner asked him if he had restored things to normal conditions and as he would have the glass when running the boiler.

7. If so, how do you know how much water is in the boiler, because the water glass contains no water?
8. How can you make the water appear in the glass again?
9. If it does not come back, what is the trouble?
10. How will you remedy it?
11. Does the water glass always show the proper level?
12. What do the gage cocks show?
13. If you opened the top one and got water, where is the water?
14. If your steam gage showed 100 lb., and the safety blew normally at 80 lb. but did not in this case, what is the trouble and what would you do?
15. What would you look for in the gage, and how is it connected?
16. Show the blowoff valve in that boiler. (See Fig. 1, showing how piped up.)
17. Several fusible plugs are exhibited to select the type of return-tubular and vertical-tubular boilers. Why will not the same one do for both?

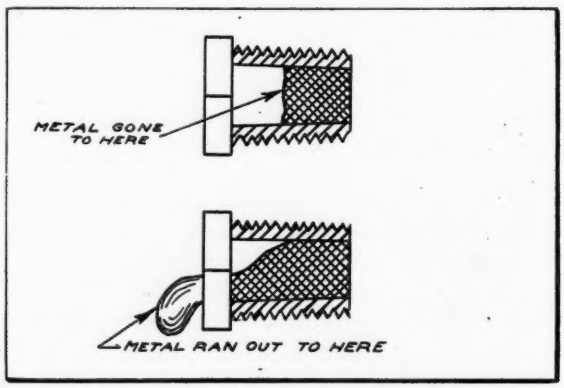


FIG. 2. FUSIBLE PLUGS

18. If the metal is molten out from the end for ½ in. or so, is the plug safe? Can a pump get air-bound, and what would you do?

RECEIVER.

Central Station Rates

I HAVE read with much interest the article, "Public Service Charges for Electric Current," by H. W. Ashley, in the issue of Mar. 15.

After comparing certain rates, he says: "The bold question is presented then: Does it cost 7 times more in Toledo and 12 times more in Indianapolis to provide current for the householder than for the manufacturer?"

The writer is acquainted with a small central station which seems to justify such discrimination, and it seems likely that there may be good reasons for the difference in rates in larger places.

The plant to which I refer, has been in operation for about 10 yr. and lights 80 per cent of the houses in the town. The rate is 15 cents per kilowatt-hour and more than half of the customers keep their bills down to the minimum charge of $1 a month.

Until about 2 yr. ago, the plant did not earn the operating expenses. Since then, the earnings cover operating expenses, but no more. There is only one fac-

tory in the town and it has an electric light plant of its own. The manager of the central station has been trying for a long time to get the factory people to buy their current of him, and they finally consented to make a test run for a week and keep close account of the coal and oil used. Then they shut down their electric light engine and used central station light for a week. The difference in cost of coal and oil consumed at the factory these 2 weeks, divided by the meter readings, showed their cost to equal 2.3 cents per kilowatt-hour, and a contract was made to furnish central station energy at that rate.

Simultaneous with the factory test for coal consumption a similar test was going on at the electric light plant, and results showed that the revenue from the factory will make the difference between operating the electric light plant at a small profit and at a loss.

I wish Mr. Ashley would tell us whether the owner of this electric light plant should be penalized for discrimination, or made to reduce his rates to 2.3 cents per kilowatt-hour to all his customers. A. S.

How the Bonus System Worked in Unloading Coal

UNLOADING COAL from cars to the coal pit, where nothing but cheap labor is used, may seem one of those jobs where the efficiency engineer's attention is not needed; but a surprising lot of time, amounting to many dollars, can be saved and is wasted every year in a large number of shops at this very job.

In a plant where the coal had to be unloaded from the cars to the pit, it was necessary to haul it by wheelbarrows a distance of about 30 ft. The chief engineer found it a rather expensive operation, and in order to reduce the cost of unloading his coal, he took the matter up with the shop efficiency man to devise some plan to cheapen the work, if possible.

After a careful observation of the job, it was found that it required 3 men anywhere from 1½ to 2 days to unload a 50-ton car of coal, the cost amounting to about 22 cents a ton; also, that their equipment and method of work were very crude. After selecting 2 husky laborers and supplying them with larger shovels and wheelbarrows, they were told that they would be put on bonus, which meant if they worked a little harder and much more systematically, they would receive extra pay. Extra pay is what they wanted, and the bonus supplied the incentive.

The result was that the coal was unloaded in a much shorter time at a reduced cost of 14 cents a ton, a saving of 6 cents a ton, or $3.00 for every 50-ton car. The men received an increase in wage from 18 cents to 30 cents an hour, or about 40 per cent higher wages.

When asked why they had accomplished their task in so short a time, the coal-covered Italians shrugged their shoulders and replied: "Da bigger da wheelbarrow save-a me time, da extra money look-a good to me." This explanation shows conclusively the basic principles of the bonus system of payments which, in general, are instruction, co-operation, more work, better work, lower cost, reward and greater efficiency.

Many more examples could be given where this system of pay has proved its worth in lowering the cost of various operations and increasing the wages of the employes; also, in creating a larger degree of efficiency throughout this and many other establishments where this method has been adopted. W. S. MYLES.

Troublesome Heater Gasket

ONE OF my feed-water heaters is of the closed type as shown in Fig. 1, and is of about 150 hp. capacity. I used to have trouble with the gasket blowing out quite often at the joint A, which was due to the fact that the 8 bolts which were next to the supporting legs of the heater could not be drawn up after the joint had been repacked and warmed up, as the 8 bolts in the heater flange at the lugs for the heater legs had to be placed so the nuts would come below the flange; this was due to the ribs on the lugs for the legs as shown in Fig. 2. As the lugs were in the way, these 8 bolts could not be followed up after repacking the joint. When this joint is repacked the heater is hoisted out of its position.

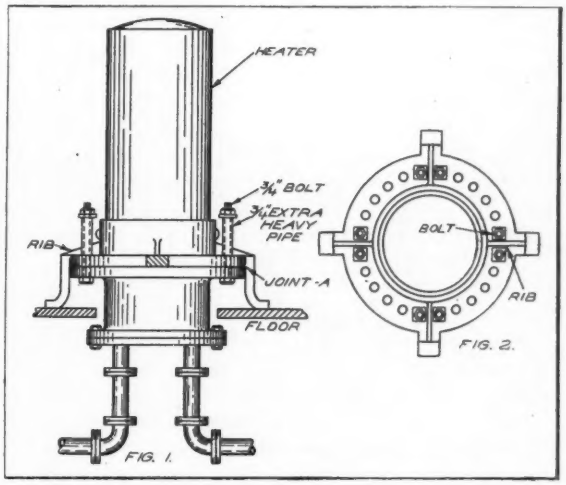


FIG. 1. ELEVATION OF FEED-WATER HEATER SHOWING LOCATION OF TROUBLESOME GASKET

FIG. 2. TOP VIEW OF HEATER

To avoid this trouble, I got bolts long enough to reach above the ribs on the leg lugs, then placed thimbles made out of ¾-in. extra heavy pipe over the 8 bolts, then a flat washer and next the nut as shown in Fig. 1.

After this improvement it is not necessary to hoist the heater out of its position; also, the bolts can be placed so the nuts are on top and above the ribs of the lugs. In this way, the bolts can be drawn up after the gasket has warmed up, when the joint is repacked. Before this improvement was made the joint had to be repacked about every 6 months; but now the gasket has been in service about one year and there is no sign of its giving out, which is due to the fact that the 8 bolts can be followed up after the packing has warmed up, thereby saving time, expense and labor.

H. JAHNKE.

How to Use Steam Tables Correctly

VERY FEW steam tables are as complete as the average user would like to have them, and even where the table is detailed for every pound increment difficulty is often experienced in getting the exact values sought.

For example, suppose your boiler operates at 100 lb. gage pressure per sq. in. Let us suppose that you want to know what the exact temperature of the water in the boiler is, just how much heat is contained in every pound of steam and in every pound of water in the boiler.

You turn to your steam table and find the column marked "pressure, lb. per sq. in. (ab.)." No doubt you know that "ab." means "absolute"—that atmospheric pressure is included; thus, if your gage pressure is 100 lb. per sq. in. and if your boiler is in New York City, the absolute pressure is 100 lb. + 14.7 lb. = 114.7 lb.

Now, my table, for example, does not give 114.7 lb. absolute. It gives 114 absolute and then jumps to 116. I must therefore make the table more usable by "estimating" values for 114.7 lb. absolute.

First, I put down the figures like this:

P (ab.)	t°F	H Heat in each lb. of steam	h Heat in each lb. of water	L Latent heat in each lb. of steam
114	337.2	1184.8	308	875.9
114.7	(1)——	(2)——	(3)——	(4)——
116	338.5	1185.2	309.4	875

(1), (2), (3) and (4), which I have left blank, are the values to be estimated. The process is simple, but I shall work it out in detail here so that there can be no doubt as to the rotation of steps. First, subtract all values as follows:

$116 - 114 = 2.$
$338.5 - 337.2 = 1.3.$
$1185.2 - 1184.8 = 0.4.$
$309.4 - 308 = 1.4.$
$875.9 - 875 = 0.9.$

Then subtract the least pressure from the pressure for which values are to be found, i. e., $114.7 - 114 = 0.7$.

The proportion to be added in each case is clearly

$$\frac{114.7 - 114}{116 - 114} = \frac{0.7}{2} = \frac{7}{20}.$$

Then, the values to be added to the smallest figures are readily computed:

$$\frac{7}{20} \times 1.3 = \frac{9.1}{20} = 0.455.$$
$$\frac{7}{20} \times 0.4 = \frac{2.8}{20} = 0.14.$$
$$\frac{7}{20} \times 1.4 = \frac{9.8}{20} = 0.49.$$
$$\frac{7}{20} \times 0.9 = 0.315.$$

Adding or subtracting, we get (1), (2), (3) and (4).

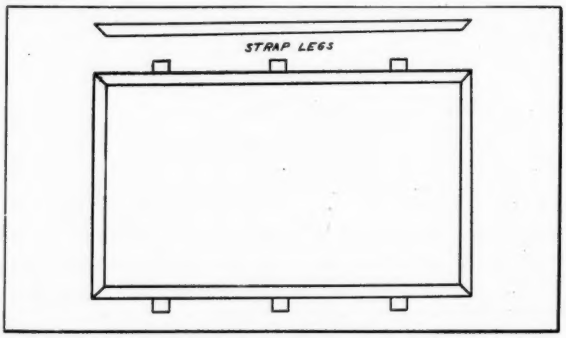
$337.2 + 0.455 = 337.655$ (1).
$1184.8 + 0.14 = 1184.94$ (2).
$308 + 0.49 = 308.49$ (3).
$875.9 - 0.315 = 875.585$ (4).

which are now ready for insertion in the table in approximate values—337.7, 1184.9, 308.5 and 875.6. Note that the latent heat decreases with increase of pressure, so the increment is subtracted. Although these figures are not "absolutely accurate" because of the assumption that variations are along a straight line between 114 and 116 lb., they will be found satisfactory for all ordinary use. The above is the simplest method of which I know.

N. G. NEAR.

Boiler Pan to Catch Sediment

HEREWITH IS sketch of a boiler pan which I have used with great success through the Red River Valley, and is especially useful to those users who pump their water out of rivers or dirty mud holes. The pan is made of heavy galvanized sheet iron, not more than 4 in. high and wide enough to permit it being slipped through the manhole easily. Legs should be riveted as well as



VIEWS OF PAN PLACED IN BOILER TO CATCH EARTHY MATTER

soldered at convenient lengths, so as to give sufficient circulation next the boiler plate. It can be made in any length desirable for ease in handling, or 2 or 3 separate pans are advisable if the mud is very bad. I have used this with great success, permitting me to run the boiler about twice as long without cleaning and with far greater economy.

MELVIN G. HENRY.

Emergency Use of a Pump

AT OUR plant we were troubled by water in our pump and engine pits. When the power house was built, many years ago, a loose-stone drain was laid to take care of this water, but it gradually became filled with sediment and at last refused to work at all.

One day it became necessary to get this water out at once, and as it was too great an amount of water to get out by the use of a hand pump, we decided to use the return pump. This pump is of the ordinary type tapped on both sides for suction. We removed the plug on the side not attached to the receiver and connected a 2-in. suction pipe into the pit. As this water was unfit for the boiler, we broke the discharge pipe and connected it to a pipe running outdoors.

Since there was no valve on the suction pipe connection to the receiver, it was necessary to flood the receiver with city water; after doing this, the pit was soon pumped dry enough to make the required repairs.

CHARLES RICHMOND.

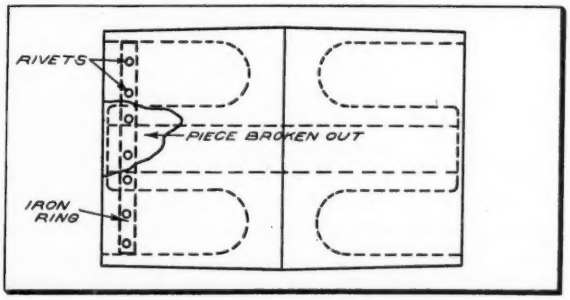
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Repairing A Pulley

I NOTICED in the Feb. 15 issue an article describing a pulley repair, which reminded me of a repair that I helped to make several months ago.

A pulley on a centrifugal pump had a piece broken out of the rim, as shown by the sketch. It was repaired by bending a piece of flat iron about 3/16 by 1 in. into a circle of the size to fit nicely inside of the end of the pulley.



METHOD OF REPAIRING BROKEN PULLEY

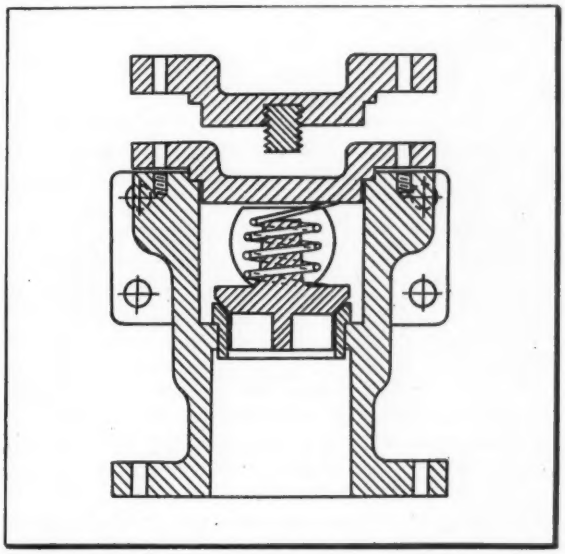
The pulley and ring were then drilled, the holes were drilled out larger at the pulley face deep enough to countersink the rivets and then the ring was riveted in place. The small piece had 2 rivets through it, while a number of rivets were placed around the pulley. The job was finished by smoothing off rivets and broken edges with a file. The pulley is still in use, as good as ever.

HAWLEY L. SCOTT.

Trouble With Pump Valves

SOME TIME ago the writer had considerable trouble with the valves on an outside packed plunger duplex pump. Each of the 16 suction and discharge valves are placed in a separate chamber, as shown in the sketch. The valves and seats are solid brass, the seat having an angle of 45 deg. The valve is held to its seat by a spring which helps to decrease the slip through the valve. When the pump was new the distance between the end of the cap and top of the stem, which limits the lift of the valve, was just enough to give the valve the proper lift; but after the pump had been in service several years, during which time both the valves and the seats had been refaced several times, this distance became too great, and in the case of 2 or 3 of the valves it was great enough to allow the valve to rise so high that the guides on the lower part of the valve would catch on the seats. This wear not only increased the percentage of slip through the seats, but when one became caught up, it was necessary to take the cap off to put it back in place; as there were 16 of them, it took a great deal of time to find the right one.

Shortly after assuming charge of this equipment, the writer discovered that some of the valves had a lift of 1¼ in., whereas for a 3-in. valve of this type, it should not be over ½ in. Further, as some of them had been replaced with new ones, the lift was not the same on all valves. After reseating the valves and seats, both of which were badly cut, they were ground in with emery, and each valve was taken separately and its exact lift measured by measuring the distance from the gasket seat to the top of the stem; from this was subtracted the distance from the seat of the cap to the bottom.



PUMP VALVE CHAMBER AND METHOD OF REPAIR

Each cap, valve and chamber was marked with a corresponding mark to prevent getting them mixed up. Then the bottoms of the caps were drilled and tapped and a ¾-in. brass plug screwed in, which was cut off at the required length to give the valve the proper lift. The manner in which the cap was repaired is shown in the sketch. After going over all the valves in this manner they were reassembled, and the pump put in service feeding boilers; with the same boiler load as before the change, the pump showed a marked decrease in speed to supply the required amount of water.

J. C. HAWKINS.

WORK HAS BEGUN on the electric power plant which will supply Cordova, S. C., with electric lights.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Power Costs

I WOULD like to ask a few questions in connection with Mr. Trautschold's interesting article on "Power Costs," in the issue of Practical Engineer for Jan. 1, 1914.

On page 100, he writes of a "saving of over 1.3 per cent by the transmission of power electrically." I would like to know more in detail just where this saving is made, whether such a saving is possible on the difference in transmission losses, investment in shafting, belting, etc., and added maintenance where engine alone is used, against electrical transmission.

On page 101, in solving for the value of CL, 18.43 is used in the formula for the value of CP, whereas, under the conditions of the example for a 250-hp. plant, this value ought to be $57.50.

Also, on this same page, the remark is made that "The cost of electric lighting as given by the formula for the plant operated electrically," is equivalent to a flat rate of about 1.5 cents per kilowatt-hour. This, the author claims, "is dependent upon a very high load factor, assumed to be 100 per cent."

This load factor does not appear correct to me, as from formula given for L L F we should get from the conditions $\frac{308 \times 10}{1000} = 3.08$, or to invert, say, roughly, 30 per cent. F. G. F.

A. The saving in electrical transmission of power is dependent upon the greater efficiency attainable in the conversion of mechanical energy into electrical energy, and the reconversion of the latter into mechanical energy, at machine or point of consumption, than is possible to obtain when transmitting mechanical energy directly. In the latter method of transmission, the losses incidental to belt slippage, journal friction of the shafting and, at high speeds, the centrifugal force acting against the effective tension in the belts, etc., all tend to reduce the power that is delivered at point of consumption. In a well-designed installation, where the shafts are in good alinement and the distance between shafting is not excessive, the loss in mechanical transmission of power may be kept as low as 25 per cent.

In electrical transmission, the first loss occurs in the conversion of the mechanical energy delivered by the steam unit into electrical energy. As the electric generator can be directly connected to the steam engine, this loss is not great and can be kept as low as 5 per cent. That is, the energy delivered by the generator will be 95 per cent of that delivered by the steam engine. Distributing the electrical energy and reconverting it into mechanical energy at point of consumption, entails further losses—conservatively speaking, a loss of 15 per cent—so that the net loss of energy between the main engine and point of consumption is somewhat over 23 per cent. The difference in efficiency of transmission is then somewhat compensated for by the greater burden imposed by the more costly equipment necessary for electric transmission. This burden may be considered as proportionally constant for any specific size of power house, for all practical purposes and, as the cost of generating power at the engine is greater in a small power house than in a large one, the economy of electrical transmission varies inversely with the size of the power plant.

The exact size of plant in which the net cost of electrical and mechanical transmission of power becomes equal depends upon the cost of developing power at the engine and will be when the greater burden (the excess) imposed by the electric equipment is equal to about 2 per cent of the net cost of power at the engine. For instance, in a plant in which the cost of power at the engine is $50 per hp.-yr., an excess burden of $1 per yr. per hp. for equipment for electrical transmission compared to that required for equipment for mechanical transmission marks the critical size of plant. In a smaller plant, with the same excess burden, where power cost $75 per hp.-yr., for instance, electrical transmission would be the more economical; while in a larger plant, with the same excess burden, where power costs $25 per hp.-yr., for instance, mechanical transmission would be the more economical.

2. The apparent error on page 101, to which Mr. Flickinger finds exception, is due to a typographical error in the text. Under "Conditions" (bottom of page 100), size of plant should be 2500 hp., not 250 hp., as given. This is evidently an error that was overlooked in proof reading, for my manuscript gives the correct value.

3. F. G. F.'s third query is evidently due to his not understanding what is meant by "load factor," and his confusing it with what I have referred to as the "lighting load factor," "LLF." The latter refers to the number of lighting hours required per year, which does not mean that during all these hours full illumination is required, such being the case only when the load factor is 100 per cent. In the example given, the illumination required (maximum) is 10,000 cp., and the examples given are based on the assumption that such illumination is required for 1000 hr. per yr.—a load factor of 100 per cent. Actually, the illumination required would probably be more like 10,000 cp. for 250 hr. per yr, 7500 cp. for 250 hr., 5000 cp. for 250 hr., and 2500 cp. for the balance of 250 hr. per yr. that illumination is required. Such distribution of light would give a load factor of 62.5 per cent, and the cost of lighting

in the plant in which the flat rate of 1.5 cents per kw.-hr. is referred to in the text, would be 2.4 cents per kw.-hr.—see following example:

250 hr. with load factor of 100 per cent.
250 hr. with load factor of 75 per cent.
250 hr. with load factor of 50 per cent.
250 hr. with load factor of 25 per cent.

4)250

62.5 per cent average load factor.

$1.5 \div 0.625 = 2.4$ cents per kw.-hr.

REGINALD TRAUTSCHOLD.

Power Plant Questions

1. What is the difference between the centrifugal and inertia governor?
2. What is the meaning of inertia?
3. Why are cylinders bored larger at each end?
4. How would you find the clearance?
5. Suppose the pistonrod was a taper fit and of the gib and key type; what is the gib for?
6. Why is it tapered?
7. What is the difference between a solid and built-up piston?
8. Where would you measure from to center the piston?
9. What is the ogee ring for, on a Manning boiler?
10. Which of the 2 plates in the waterleg is the thicker?
11. Where do staybolts fail?
12. What do you know about the Fitchburg engine?
13. What type of governor has it?
14. What kind of valves has it?
15. Suppose the valves were leaking, what would you do?
16. When would you do it?
17. How would you know they were not too tight?
18. If one of the valves was loose from the valve gear and left open, what would close it?
19. How can you tell that an engine with a shaft governor will not run away without taking the valve chest cover off?
20. If there was end play, what would you do?

A. K.

A. The meaning of the word "centrifugal" is "tending to recede from the center." The centrifugal governor, of which the Buckeye is the most widely known type, consists of 2 arms hinged to the hub of the governor wheel on the opposite sides of the eccentric. The ends of these arms carry a weight and are free to swing in the arc of a circle between the shaft and the rim of the wheel. The eccentric is loose on the shaft and connected to the arms by links, which, as the weights move towards the rim of the wheel, due to the centrifugal force, rotates the eccentric on the shaft, changing the angular advance, and regulating the point of cutoff. The centrifugal force of the weights is counter-balanced by the tension of long springs. In the inertia governor, of which the Rites is the best known type, a heavy weight, in the shape of a long bar pivoted near the center to a spoke of the wheel, is connected to the eccentric. The principle of the inertia governor is that when the speed of the engine decreases slightly the force of inertia forces the bar ahead, and either changes the angular advance or the travel of the valve to give later cutoff. When the speed increases, due to the later cutoff, the speed of the wheel overcomes the force of inertia of the weight, and it moves back, changing the point of cutoff to reduce the speed. The force of inertia is counter-balanced by a heavy spring, the tension of which governs the speed.

2. The definition of "inertia" is "that property of matter by virtue of which it retains its state of rest or motion, so long as no external cause occurs to change that state." When applied to engine gevorners, this means that the inertia of the weight will be constant, and, therefore, give constant supply of steam to the cylinder until the change of load changes the speed of the wheel, which either opposes or assists the force of inertia of the weights.

3. Cylinders are bored larger at each end, or counterbored to prevent the piston ring from wearing a shoulder at the end of the stroke. The counter-bore is of such length that when the piston reaches the end of the stroke, the ring will pass part of its width over this space, preventing a shoulder from wearing at this point. Also the counterbore gives a true diameter of the cylinder, which is not affected by the wear of the piston, and from which the cylinder may be alined, or the piston centered in the cylinder. Also, it is of help in setting the boring bar when it is necessary to rebore the cylinder.

4. This question is not clear. It may mean the clearance of the piston and cylinder head, or it may mean the per cent cylinder volume which the volume of the ports and clearance space represents. If it means the piston clearance, it is found as follows: First, locate the striking points of the piston. To do this, take out the crankpin bearings, or disconnect the connecting rod, and push the crosshead back until it strikes solid against the cylinder head. Make a permanent mark on the frame opposite some point on the crosshead, for instance, the center of the wristpin, using a square to get the true location. Move the crosshead to the other end of the stroke, bringing the piston solid against the head, and make a second permanent mark. These are the striking points of the cylinder and will not be changed unless the length of the rod is changed. Connect up the rod, and put the crank on the center; then make a temporary mark on the frame opposite the same point on the crosshead. Do the same on the other end. These temporary marks will be from ¼ to ⅝ in. inside the other marks. The distance between the permanent and temporary marks on each end will show the amount of piston clearance on that end.

To find the clearance volume, place the crank on the center, close the drain valves, remove the valve and fill the space with water which has previously been weighed. Fill the space up to the valve seat. Find the number of cubic inches of water used, and divide it by the volume of the cylinder in cubic inches to get the per cent of clearance. It is best to repeat the measurements several times and take the average as the volume of clearance space. With engines having the valves located on top of the cylinder this is an easy matter, but when the

valve is located on the side of the cylinder, the ingenuity of the engineer may be called into use to get the clearance space full of water, and the correct measurements of the water actually required to fill this space.

5. The principal use of the gib in the gib and key type of connecting rod, is to provide a simple and solid means of tightening the bearing, and to prevent the strap from springing. Also, it provides a means whereby the clearance space may be equalized when the piston rod is keyed to the crosshead. This is done by backing out the key, and placing a steel shim between the bearing and strap or rod end, depending on the type of connection. Some rods require it in 1 place, and some in another, the proper location being decided for each individual case by the engineer. This shim, if properly placed, will increase or decrease the length of the connecting rod to equalize the piston clearance. A little thought on the part of the engineer will show just where this shim should be placed. Where the piston rod is screwed into the crosshead, the clearance is equalized by screwing the rod in or out of the crosshead as required.

6. As the key slot in the end of the rod is cut square and the key is tapered, the gib must be straight on 1 side and tapered on the other to give a bearing surface its full length to both the key and bearing. There are usually 2 gibs, 1 each side of the key. When the gibs and key are placed together, the over-all width is the same on both ends, and pushing the key down farther increases this width, but the relation between the 2 ends remains the same.

7. A solid piston is cast in 1 piece (usually hollow), the ring grooves and bore for the rod being turned in the lathe. The built-up piston consists of a hollow spider fitted to the rod and carrying a bull-ring, packing ring, follower plate, and sometimes an extra bearing ring lined with some anti-friction metal, all being held in place by cap screws or studs screwed through the follower plate into the spider. In the solid piston, snap rings are usually used, which must be sprung into place, while the rings on the built-up type may be slipped into place, and adjusted by springs beneath the ring when the follower plate is off. All small pistons are of the solid type; but the larger ones are, as a rule, built up, as this type is lighter, especially in the larger sizes. It is so constructed that it may be centered in the cylinder when it becomes worn low, which usually cannot be done with the solid type.

8. To center the piston in the cylinder, measure from the center of the piston rod to the counter-bore with a pair of hermaphrodite calipers, using at least 4 equidistant points in the counter-bore, and adjust the centering screws accordingly.

9. In this type of boiler it is desirable to have a grate area greater than the area of the barrel of the boiler, therefore the furnace is made of a larger diameter. In connecting this furnace to the barrel of the boiler, some form of an offset or tapered joint must be used. These boilers are very long, and this point is subjected to a great deal of expansion and contraction which must be taken care of, to prevent rupture of the plate at this point. This can best be done by means of the ogee ring, as it permits this bending action without subjecting the fiber of the plate to a sharp breaking strain.

10. The inside plate of the furnace is made thicker than the outside plate, usually about ⅛ to 3/16 in. thicker.

11. The staybolts in a Manning or any other similar type of boiler, having a deep internally fired furnace or waterleg, usually fails at the upper end of the furnace. The reason for this, is that the inside sheet is subjected to a higher temperature, especially if coated with scale, than the outside sheet, and the expansion is greater. In long waterlegs the difference in expansion between the inside and outside sheet is great enough to cause a bending strain on the staybolts at the upper end. This repeated bending may, in time, cause them to break off more easily than those lower down.

12. The Fitchburg engine is of the girder frame or tangye-bed type, long stroke, and slow to medium speed. The cylinders are cast thick enough to stand 3 reborings, and the high-pressure cylinder will then stand a working pressure of 150 lb. The ports are short and direct, and designed to reduce the heat loss to a minimum. The valve gear is of the Corliss wristplate action, driven by a shaft governor which shifts the eccentric across the shaft, changing the angle of advance to time the cutoff. The valves are 4 in number, operated by a special cam arrangement, through which the valve gear drives them. This valve gear produces an indicator diagram similar to a drop cutoff Corliss.

13. The governor is of the centrifugal shaft type, having 2 weight arms counter-balanced by long springs. These weight arms are connected by links to a second set of weight arms pivoted to the hub, and so arranged that the free end is connected to lugs on either side of the eccentric, which moves it straight across the shaft, giving constant lead to the valves at all points of cutoff.

14. The valves are of the double-ported piston type, 2 steam, and 2 exhaust. All valves are balanced, and have short travel with quick movement at the time of opening and closing. They have no spring rings, but are of a special design to be kept steam tight by employing an expanding ring and internal cone which may be adjusted to take up the wear.

15. When it becomes evident that the valves are leaking, due to wear, which may be discovered by testing with the indicator cocks, the valves may be tightened up in the following manner: Remove the valve bonnet, which will make the valves easily accessible. It will then be seen that there are 2 bolts tapped into the center expanding cone, also 2 tapped into the head and bearing against this cone. To expand the ring, slack up on the first 2 and tighten up on the last 2, which forces the cone into the expanding ring and increases its diameter from 0.0001 to 0.0625 in., as desired.

16. The valve should be adjusted about once a year, or oftener if found necessary to prevent leakage, and this should be done while the cylinder and valves are hot The reason for this is that the valve is expanded then, due to its heat, and there is less danger of getting it too tight.

17. After getting them adjusted, work the valves back and forth by hand, to see that they do not bind. If a thickness gage is at hand it may be used to determine

the clearance, which should be about 0.002 in. between the valve and seat. The exact amount of clearance will depend on the size and temperature of the parts, the larger valves requiring more clearance than the smaller ones.

18. The steam pressure acting on the unbalanced area of the steam valve, would close it. In actual practice, it is found that, as a rule, when the packing is not too tight, the back end of the slot in which the roller works shows very little wear, which proves that the valve closes itself, or with very little pressure from the roller.

19. If the governor parts and valve gear appear to be in proper adjustment, it would be impossible to tell how fast the engine would run without turning steam on to try it. If the steam chest is opened, and the governor blocked out against the stops, the amount of lead showing will enable the engineer to determine if it will run away. An increase in lead of 1/32 in. might be sufficient to cause it to run away. This is such a small amount that it could not be found without trial or by very close measurements with the valve exposed.

20. By "end play" I assume that lost motion somewhere between the valve and governor is meant. I would examine each part, and take whatever steps the situation warranted to reduce the lost motion to a minimum. The several parts must not be clamped too tight, as it is very apt to cause racing.

Refrigeration Questions

WHAT IS meant by properties of saturated ammonia?

2. What is meant by superheated ammonia, and why is it superheated; is it superheated after it is discharged into the condensers, and what gain is there in superheating it?

3. Please explain how the ice machine is handled, according to the thermometers, in suction and discharge line of the machine? J. W. G.

A. The properties of saturated ammonia, as given in the tables, are the temperature for a given pressure, the heat required to vaporize the ammonia at any pressure, or the amount of heat that must be taken out of the condenser from a pound of ammonia, at any pressure, in order to change it into a liquid; the volume of a pound in cubic feet, the weight of a cubic foot in pounds, for both gas and liquid. These values are necessary in making computations as to the action of the refrigerating plant.

2. "Superheated ammonia" is simply ammonia which has been heated above the temperature which it would naturally have at any given pressure. For any liquid, the temperature to which it can be heated, rises as the pressure increases; below that temperature, it will remain in the liquid state. After it reaches its normal temperature for a given pressure, if the heating be continued, a portion of the liquid will change into vapor. In the case of water, we call this steam. After the liquid is all evaporated, if we continue heating, keeping the pressure the same, the temperature will again rise, the heat being used up in raising the temperature of the vapor and making it more nearly like a permanent gas.

After it comes into this condition, it is called "superheated." Ammonia will not be superheated after discharged into the condenser, because when it enters the condenser, the temperature begins to fall and the ammonia to condense or change from a vapor into a liquid. Superheating that occurs at all must occur in the compressor cylinder.

There is no advantage in superheating ammonia; in fact, it is a disadvantage and should be avoided whereever possible. When it occurs, it is due to the fact that the compressor capacity is not sufficient to take care of the plant.

3. The handling of a compressor is too long a subject to take up in a letter. We have in hand now a series of articles, which are being prepared for publication, on the machinery of the refrigeration plant, by A. G. Solomon, and among these you will find a great many hints in regard to the practical operation of plants. We would advise you to read these articles carefully.

If you want immediate help, I would suggest that, if you have back files, in the Feb. 1, 1912, issue, page 116, you will find a helpful article by C. Nessler; an article in May 1, 1912, page 477, by Walter C. Edge; "Ammonia Compressors," Nov. 1, 1912, page 1085.

A. L. R.

Racing Engine

READING THE question by P. W. L., on page 317 in the Mar. 1 issue, in regard to the racing of his engine mornings when starting up, calls to mind the trouble I had some years ago with a high-speed engine. This engine would race for a short time after coming up to speed and then slow up again, then run at the regular speed for the day's run without any trouble. The racing was worse on Monday morning than other mornings.

It took me a long time to find the cause of the trouble, when, one cold Monday morning, the racing was worse than before. After shutting down the engine and examining the governor closely, I noticed that the grease in the governor bearings was very stiff, which, to my idea, prevented the governor from working freely. It was my intention at first to clean the grease from the bearings, when I noticed a blow torch handy and heated up the bearing a little, so as to soften the grease on them. After this, when the engine was started, there was no racing of the engine, so the cause of the trouble was found. As the room in which the engine was located would get cold during the night, more so from Saturday night till Monday morning, during this time the engine was idle, and the grease in the governor bearings would get so stiff as to prevent the governor from acting as it should when first starting up the engine on a cold morning; thereafter I used a very light grease and had little trouble.

Perhaps P. W. L.'s engine is also located in a room which gets cold during the night when the engine is idle, or the grease he is using is not suited for the work. These points should be looked after, or if his engine is of the Corliss type, the oil in the governor dashpot may get too stiff during the night if the engine room cools off too much in cold weather. If the oil in the dashpot is not of the right sort or gets too stiff, it will prevent the governor from acting freely, when the engine will race or slow down when starting in the morning.

H. JAHNKE.

PRACTICAL
ENGINEER

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Smoke Abatement

Well-informed engineers and firemen have known for a long time the requirements for complete combustion. To apply these principles practically, has been difficult. Smoke—i.e., uncombined carbon in the flue gases—is recognized as a condition of incomplete combustion, but to eliminate smoke by admitting more air to the furnace, in many cases, means lower efficiency.

Probably the greatest aid toward smoke abatement has been the use of furnaces properly designed for the coal which they are to burn. It is necessary, of course, that these be constructed and operated correctly or with the most favorable design smoke will be produced.

It is gratifying to know that the Government is making an exhaustive study of the smoke abatement problem and in this issue is published an article by Mr. Flagg, giving the results of some of his experiments with different kinds of furnaces and methods of firing. The comparatively small power plants equipped with hand-fired furnaces have been the chief offenders against smoke ordinances, and the Federal Bureau of Mines has directed its efforts toward the solution of the problems confronting the managers of these plants.

One point brought out in the article referred to, which has been overlooked by many, is that the constituents of the volatile combustible matter in coal should be studied with as much care as the percentage of volatile matter. Further investigations along these lines will be eagerly watched by those interested in the engineering field.

Footsteps in Getting Ahead

Every man of us wants to get ahead. One reason why more of us do not realize this aspiration is that we want to get ahead all at once. We outline what we would like to be or to do, and rest content with ruminating upon that goal of our journey, instead of taking the necessary actual first step toward it.

Yet taking that first step is all that we have to do *now;* the steps following we do not have to take till *then.* If one has to walk a mile or less, he does not sit eternally and think of what will occur at the end of his journey or anywhere along the way; he just sets out to walk. He does something now which might seem infinitesimal compared to his distance to be covered: he takes the first step. That is all he has to do; it is all he can do, now. That step taken—but not till then—comes the next step, and the next, and so on. The "left, right, left, right" business is what brings him to his goal, and nothing else in the world will do it.

So in any journey, or pursuit, or ambition. Why, it is a fact that the very word "ambition" means a *going!* The next thing is all that we have to do. We can always find and take the very next step, though it may be a short one. Perhaps it is tightening a bolt, perhaps it is writing a letter, perhaps it is getting up in the morning with the alarm-clock instead of a couple of laps behind. Taking the next step is concentration; it starts things; it gives momentum; it opens the way. First thing one knows, one has arrived!

New Notes

THE UNITED STATES GRAPHITE Co. recently announced the death, on March 1, of its president, Eugene McSweeney.

A. S. CAMERON STEAM PUMP WORKS, 11 Broadway, New York, announces the opening of a branch office and warehouse in Peoples Gas Bldg., Chicago, under the management of M. P. Frutchey.

ELLIOTT H. WHITLOCK, M. E., after 18 yr. of experience in the carbon industry and the management of plants in other lines, together with a broad practical knowledge of engineering, announces the opening of his office at 1506 West 112th St., Cleveland, O.

THE UNIVERSAL ICE AND COLD STORAGE Co., located at Monongahela, Pa., will soon begin the erection of a modern ice and cold storage plant. The company will be incorporated and have a capital stock of $75,000. The directors of the company are Jos. S. Roth, Fred J. Roth and Paul E. Berry.

ANNNUAL CONVENTION of the Iowa State Association of Stationary Engineers will be held in Des Moines, Iowa, June 3 to 5. An exhibit of power-plant apparatus and supplies will be held, booths being rented for $15 each. Further information can be had from John Devine, 655 E. 1st St., Des Moines, Iowa.

NEW JERSEY State Association of Stationary Engineers will hold its annual meeting in Jersey City, N. J., May 28 to 31, and in connection with this will have an exhibition in Elk's Hall, for which spaces are now on sale at $20 each. Further information can be obtained from Martin J. Hickey, 65 Mercer St., Jersey City, N. J.

THE FOLLOWING ARTICLES of incorporation were filed with the secretary of state recently.

Thorsby Light and Water Power Co., of Chilton County, Ala., authorized capital stock, $2000. Paid in, $1070. Incorporators: A. K. Horn, E. W. Butler, S. H. Herbert, P. K. Villadsen, M. C. Crampton, J. R. Martin, L. F. Gerald.

PRATT & CADY Co., Inc., Hartford, Conn., announces its acquirement of the entire business of the Pratt & Cady Co. There will be slight change in the personnel of the organization and the manufacture and sale of the line of high quality valves, cocks and hydrants, for which the old company has become famous during the past 36 yr., will be continued. Grateful appreciation is extended by the new company to all those who, by their loyalty and patronage, have made the continuance of the business an assured fact.

PLANS FOR A SERIES of buildings to cost $100,000, to be erected near Beaver, Pa., for the commissioners of Beaver County, are nearing completion in the offices of Architects Carlisle & Sharrer. The program includes an administration building, 40 by 60 ft., 3 stories; women's cottage, 41 by 40 ft., 2 stories; dining room, kitchen, chapel and hospital, 40 by 98 ft., 2 stories, with power plant; laundry and bakery and basement; tubercular patients' building, 30 by 60 ft., 2 stories; pest house, 30 by 60 ft., 2 stories.

THE CENTRAL STATES EXHIBITORS' Association is arranging for exhibits in connection with the conventions of the State Engineering Societies, the dates of which are as follows: May 20 to 22, Peoria, Ill.; June 3 to 5, Louisville, Ky.; June 10 to 12, Indianapolis, Ind.; June 17 to 19, Akron, O.; July 15 to 17, Muskegon, Mich.; July 29 to 31, St. Joseph, Mo.; August 12 to 14, Minneapolis, Minn.

Each exhibition is held in connection with a convention of the stationary engineers of that particular state, and arrangements may be made either for exhibits at all the conventions, for which the cost is $70 for exhibit space, or for any one or more of the conventions separately, at a cost of $15 for each convention. Full information can be had from Chas. H. Fiske, Room 330 Manhattan Bldg., Chicago.

IN THE Daily Consular and Trade Reports, under Foreign Trade Opportunities, we find the request of a South African shipper and exporter for the names of American manufacturers of galvanized pipes and fittings, also proposals are requested by the Director of Public Works in Madrid, Spain, for the concession and construction of an electric tramway in that city. The estimated cost is $23,000, and the rolling stock must include at least 2 electric cars; work is to be commenced within a month from date of award, and finished within 3 months. The proposals are to be submitted through a resident agent in America before April 22, and lists of such agents can be obtained from the Bureau of Foreign and Domestic Commerce, Department of Commerce, Washington, D. C.

THE FOXBORO Co., recently organized under the laws of the Commonwealth of Massachusetts, has taken over all assets and liabilities of The Industrial Instrument Co., of Connecticut, which was a holding company, and of The Standard Gage Mfg. Co., of Connecticut, with factory at Foxboro, Mass.

The Foxboro Co. manufactures the Foxboro Improved recording gages, thermometers, tachometers and pyrometers, which are sold by The Industrial Instrument Co., having main office at Foxboro. There are no changes in the personnel or policies of the companies, the changes mentioned above being made to concentrate and simplify the organization.

THE POWER PLANT of the McCray factory, Kendallville, Ind., to cost approximately $55,000, is rapidly nearing completion. Work on the installation of a new electrical plant for power and light was started over a year ago, when the boiler rooms were overhauled and a huge smokestack erected. Some months ago work was started on the engine room and plant proper and the result has been that the company now has installed a 250-kw. generator and a 300-hp. Corliss engine, completely equipped. In the engine room, which is 35 by 45 ft., are installed large cranes for the handling of heavy machinery. The switchboard is of the latest type on the market. The entire building is fireproof. The complete electric outfit, including the engine, generator, motors, electric wiring, which is carried to all parts of the building in tunnels, aggregates a cost of $30,000. In all, there are 60 motors, ranging from 1 to 35 hp., and each motor will drive an individual machine.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

Non-Return Valves for Preventing Accidents

ACCIDENTS TO OPERATORS AND BOILERS PREVENTABLE BY AUTOMATIC VALVES; NEW TYPE NON-RETURN VALVE. BY OSCAR C. SCHMIDT

THE various types of valves used around a power house may be divided into 2 classes; those which perform their function of opening and closing when operated by external force, and those which operate automatically to perform that function, when conditions of operation or the unexpected, make it necessary that they shall operate quickly and positively. An illustration of a type of automatic valve which must open when the pressure in a boiler reaches a predetermined amount is the well-known safety valve of either the lever

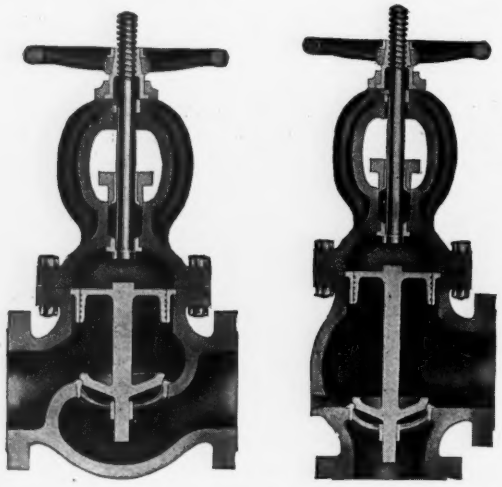


FIG. 1. STRAIGHTWAY CUSHIONED NON-RETURN VALVE
FIG. 2. ANGLE CUSHIONED NON-RETURN VALVE

or spring type. In contrast to this type is a form of valve which must close automatically under conditions that are practically the reverse of the conditions under which the safety valve must operate. These types of valves are known as non-return valves.

The most important uses of the non-return valve are to equalize the pressure between the different units in a battery of boilers, and to prevent the flow of steam from traveling in a reverse direction to its normal flow.

In case a tube blows out in a boiler, the non-return valve closes automatically, owing to a reduction of pressure, and prevents the header steam from entering the boiler. It acts also as a safety stop to prevent steam being turned into a cold boiler when men are working inside, because it cannot be opened when there is pressure on the header side only.

The greatest danger to which boiler men, repair men and insurance inspectors are subjected when working around a power plant is when they are required to enter an empty boiler which is connected by pipe lines to other boilers under steam. Should the steam be allowed to enter the boiler when anyone is working within it, there is no way in which the man inside can protect himself, and his life is in jeopardy. This occurrence takes place all too frequently, and may be due to a leaky stop valve, or it may be due to the negligence of some employe who, being ignorant of the fact that someone is inside the boiler, turns on a steam valve, which allows live steam to enter the boiler, and a death is apt to be the result.

To be successful, a non-return valve should not open until the pressure in the boiler is equal to that in the header. It should not stick and become inoperative, it should not hammer or chatter while performing its work, and it should be so designed that wire-drawing will not cause wear on the seat and the resulting leak.

In adopting these fundamental principles of safety necessary for the operation of a non-return valve, the Nelson Valve Co. has added additional operating and construction details. The valve is so constructed that it operates automatically, as an ordinary check valve, or as a stop valve It contains an internal dashpot with full area of the valve opening to cushion the opening and closing of the valve, and being always at the same temperature as the other working parts, there can be no unequal contraction or expansion to bind the piston. Piston and dashpot are made the same depth, so that in normal operation, no shoulder can be formed.

The disc is provided with a lip below the finished seating surface, to give an easy flow of steam, and with the necessary short-stroke avoid damage from wire drawing, by absorbing this wear below the seating surface.

In the installation of these valves of either the angle or globe pattern, they should be so placed that the pressure is always under the disc, with the stem vertical. They can then be packed when open and under pressure.

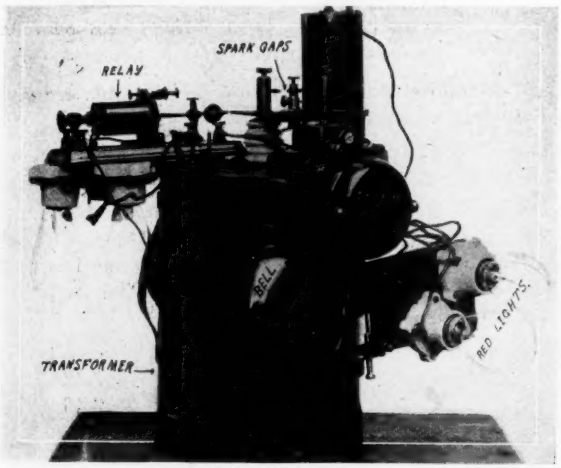
AT GLENDIVE, MONT., a new power plant will be constructed during the coming spring and summer, at a cost approximating $75,000, by the Glendive Heat, Light & Power Co. The building is to cover 50 by 70 ft., 2 stories in height, with equipment of two 500-kw. steam turbines, a 175-ft. smokestack, boilers, switchboard, condenser, ash and coal-handling equipment, and auxiliary apparatus. General Manager Frank C. Hughes will have charge of the contracts and construction.

The Smoke Monitor

ELECTRICAL DEVICE FOR INDICATING WHEN FURNACE IS SMOKING

IN many of our larger cities a considerable part of the smoke, the dust, the fumes, etc., are due to the carelessness and negligence used in operating furnaces, either in the process of hand firing or in mechanical stoking. The best furnace apparatus will belch out dense black smoke (when burning some kinds of soft coal) if improperly operated. What can solve a problem of this sort? Education. Firemen and the operators of mechanical stokers should know how to burn all the coal—how to prevent large amounts of fuel from being sent up the smokestacks as a waste and as a pollution of the air of the neighborhood.

What does each fireman need? What does each stoker operator need? A "smoke abatement conscience." Something to tell him when dense smoke is being made. Something to tell him this at the time—when he could avoid it all.



SIDE VIEW OF SMOKE MONITOR

The smoke monitor is an apparatus designed to do this. It causes a bell to ring and a red light to shine right above the furnace door whenever smoke is being emitted. It causes a red light to be turned on at the manager's office desk whenever the city smoke ordinance is being violated. In every such a plant there will be placed a set of directions telling just how the firing may be done without smoke being produced.

The purpose of the monitor is that of telling when fuel is being wasted and when the smokestack is polluting the surrounding air. Proper combustion will take place when the monitor is not in action. Good firing will also result in less soot coating the boiler tubes.

The smoke monitor apparatus is a simple piece of electrical apparatus and the side view herewith shows the bell, red lights, relay, transformer and spark gaps. The transformer is small, using some 80 or 100 watts. There are 2 high-voltage spark gaps—one in the smokestack and the one shown in the figure. When there is no smoke the electrical discharge (by using spark gaps of the proper length) takes place in the stack. This is due to the intense ionization existing in the furnace gases. When smoke particles are present, however, the ions combine with these particles, making the resistance of the spark gap in the stack too great for any appreciable current to flow. The high voltage current then flows between the electrodes on the transformer and this causes the bell and light circuit to be closed by means of the relay. The relay may be operated by an ordinary wireless coherer or similar device.

The smoke monitor uses but little current, contains no moving parts except the relay contacts and the bell tapper and should not require much adjustment once it has been set. It is a recently developed product of the Scientific Instrument and Electrical Machine Co., Mechanicsburg, Pa.

Tests of Used Oil

PROPERLY PURIFIED USED OIL PROVES TO BE AS GOOD AS NEW OIL FOR LUBRICATING PURPOSES

EVEN today, one frequently hears engineers speak of oil "wearing out," some even going so far as to maintain that after oil has been in use for a certain length of time, it should be discarded and replaced by new oil.

In order to determine exactly what deterioration oil suffered when in constant use, The Richardson-Phenix Co. recently had a rather elaborate series of tests made on different samples of oil at the laboratories of Cornell University.

These tests prove conclusively, that if oil is properly filtered, it can be used over and over again indefinitely without losing any of its lubricating qualities. To show the value of the information obtained in these investigations, the data secured from the Hotel McAlpin tests has been selected as representing the most severe operating conditions.

The power plant of the Hotel McAlpin, New York City, is equipped with a Richardson central oiling and filtering system, supplying flooded lubrication to 4 Wetherill engines having 48 points of lubrication, 2 Clayton air compressors having 6 points of lubrication, 2 Laidlaw-Dunn-Gordon compressors having 16 points of lubrication and 1 Wetherill crank-and-flywheel pump having the 32 points of lubrication, making a grand total of 134 points of lubrication supplied by the system.

This plant operates 24 hr. per day, 365 days a year, and the average temperature in the engine room is 100 deg. F. On account of the great variety of machines lubricated, the high load factor and the exceptional temperature conditions, the work imposed on this lubricating system is probably as severe as can be found in any power plant. The oil is a good grade of mineral oil, known as "Extra Brand Engine Oil."

To find out exactly how much oil was circulated through the oiling system, 10 tests were made at the power plant, and it was found that the average amount of oil handled by the lubricating system was 150 gal. an hour, or 3600 gal. of oil a day. This is an equivalent of 1800 barrels per month.

To determine the changes undergone by the oil, a sample of the new oil as received in barrels from the manufacturers was secured and also a sample of the oil drawn off from the clean oil compartment of the filter.

These samples were sealed in the engine room and shipped to the testing department at Cornell University, where without any further purification or filtration, a series of tests were made under the supervision of Professors Carpenter and Sawdon. The results of these tests are given in the accompanying tables and curves and to say the least, they prove that a modern oiling system is without a doubt one of the best investments that can be made in any power plant.

A series of friction tests were made on a Thurston railroad lubricant tester, having a hardened steel journal and bronze bearings with a total area of 20 sq. in. The summary of these tests is shown in the following tables:

SAMPLE "A"—NEW OIL

Press. on bearing, total lb.....	1500	3000	4500	6000	7500
Press. on bearing, lb. sq. in.....	75	150	225	300	375
Duration of test, min.....	120	50	60	60	50
Temperature of bearing, max...	114.5	120.0	129.5	139.0	143.5
Temperature of room, aver.....	68.2	70.7	71.5	72.5	73.0
Diff. in temp. bearing and room.	46.3	49.3	58.0	66.5	70.5
Rate of feed, drops per min. aver.	34.8	38.4	38.6	37.0	38.2
Speed, r.p.m.	362	361	361	361	359
Speed, ft. per min.....	355	354	354	354	352
Minimum coeff. of friction.....	.011,66	.006,66	.005,33	.004,58	.003,78

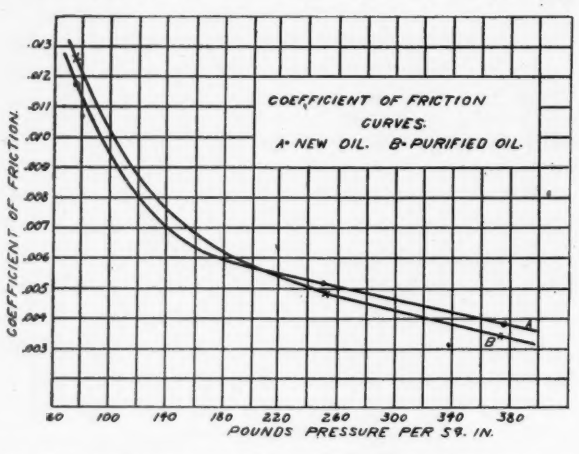


FIG. 1. COMPARISON OF THE COEFFICIENTS OF FRICTION OF NEW AND FILTERED OIL

SAMPLE "B"—PURIFIED OIL

Press. on bearing, total lb.....	1500	3000	4500	6000	7500
Press. on bearing, lb. per sq. in..	75	150	225	300	375
Duration of test, min.....	150	60	60	80	50
Temperature of bearing, max...	120	125.5	132.5	144.5	147.2
Temperature of room, aver.....	74	74.8	75.3	77.0	77.5
Diff. in temp. bearing and room.	46	50.7	57.2	67.5	69.7
Rate of feed, drops per min. aver.	38.9	40.3	37.4	40.5	41.4
Speed, r.p.m.....	363	363	360	361	358
Speed, ft. per min.....	356	356	353	354	351
Minimum coeff. of friction.....	.012,65	.007,17	.005,22	.004,58	.003,67

The coefficient of friction in the above table represents the lowest value found for each load, that is as soon as a given load is applied, the coefficient is, of course, high at first, gradually falling off until it becomes practically constant. This latter figure is the one shown in the table and represents the value that would obtain in ordinary practice where engines operate continuously for more than an hour. The temperature readings given in the table are the highest temperature reached for each load, that is, as each new load is applied, the bearing gradually heats up until the temperature becomes practically constant.

The difference in temperature between the bearing and the room has been plotted in the curves shown in Fig. 2. Curves showing the coefficient of friction of the new and filtered oil are shown in Fig. 1.

About 3 barrels of new oil are added to this system a month, the system, as a whole, has been in operation for over a year and a half and the question naturally arises, what physical changes, if any, has the oil undergone during this extended period?

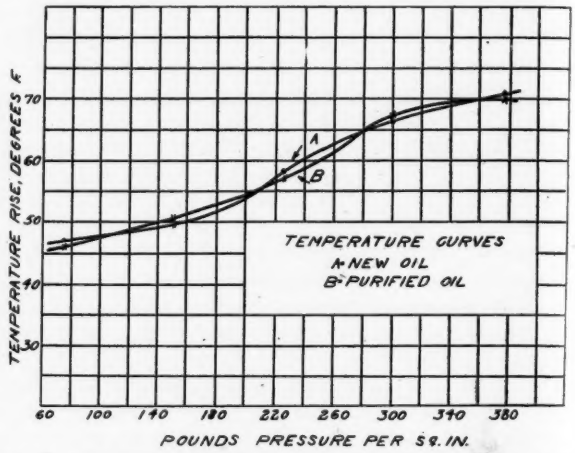


FIG. 2. TEMPERATURE RISE OF BEARING USING NEW AND FILTERED OIL

The results of tests made to determine this are given in the following tables:

PHYSICAL PROPERTIES

SAMPLE "A"—NEW OIL

Color: Medium red, translucent. Flash point: 410 deg. (open cup). Burning point: 460 deg. F. (open cup). Specific gravity at 60 deg. F. water as 1 = 0.895. Viscosity (with Olsen viscosimeter). Water as 1 at 60 deg. F. Time, 27.9 sec. for 100 cc.

Temperature F.	Time 100 cc. sec.	Relative Viscosity
70	97.0	3.48
70	96.6	3.46
71	96.2	3.45
97	59.8	2.14
94	61.8	2.21
130	45.6	1.63
132	43.8	1.57
214	34.0	1.22
215	34.2	1.225

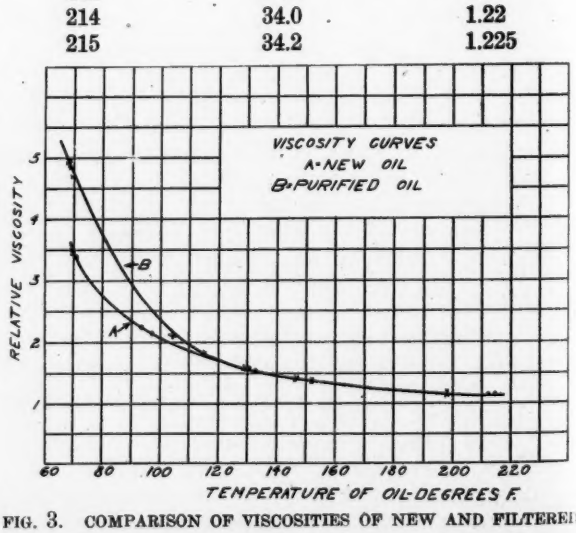


FIG. 3. COMPARISON OF VISCOSITIES OF NEW AND FILTERED OIL

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-lea f cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps.

PRACTICAL ENGINEER

RESISTOR METALS AND ALLOYS

Name of Substance.	Physical Condition or Composition of Substance.	Resistance in Ohms per circ. mil. foot at 68° F	Temperature Coefficient of resistivity for one degree, F	Specific gravity	Approx. Maximum Working Temperature in degrees, F	Approx Melting Point in degrees, F
Copper		10.4	0.00362	8.89	500	1980
Platinum		67.4	0.00324	21.5	2700	3180
German Silver	18%-Copper-Nickel-Zinc	200	0.000172	8.5	500	1880
German Silver	30% " " "	200	0.000111	8.5	500	2120
Ia Ia Soft	Copper-Nickel	288	0.00000278	8.4	700	2250
Advance	" "	294	nil	8.9	700	2300
Constantin	" "	300	0.00000278	8.9	700	2300
Ideal	" "	300	0.00001	8.85	700	2300
	Nickel-Steel	511	0.00039	8.10	1100	
Krupp	" "	511	0.00035	8.14	1000	
Superior	" "	595	0.0004	8.14	1000	2400
Climax	" "	320	0.0003	8.09	1000	2250
Phenix	" "					2100
Excello	Nickel-Chromium	550	0.00009	8.9	2000	3000
Nichrome	" "	600	0.00024	8.15	2200	2500
Calido	" "	600	0.00019	8.4	2500	2500
Nichrome II	" "	665	0.00009	8.02	2500	2500
Chloride	" "	750			2500	2575
Carbon	Retort	1325*	not constant	1.9	6900	6700
Graphite	Acheson	4675*	" "	2.2	6900	6700
Carb. Filament	Treated	6000*	" "		8500	6700

—THE ELECTRIC JOURNAL.

PRACTICAL ENGINEER

DIMENSIONS OF SMALL VERTICAL GENERATING UNITS

K. W.	No. Poles	Rev. Per Minute	A	B	C	G	I	O
2½	4	625	30½	32	9½	22	2½	10½
3½	4	525	39	38½	10	33¼	3¼	10½
5	4	650	39	38½	10	33¼	3¼	10½
6	4	400	51½	50½	12¾	44½	5⅛	12¾
7½	4	500	51½	50½	12¾	44½	5⅛	12¾
8	6	375	52	55¼	15½	44½	0	15¼
10	6	450	52	55¼	15½	44½	0	15¼
10	6	350	56	55¼	15½	48¾	0	15¼
12½	6	425	56	55¼	15½	48¾	0	15¼
15	6	325	59½	65¼	15½	50	0⅝	17
17½	6	400	59½	65¼	15½	50	0⅝	17
20	6	325	61	69¼	21½	50	0⅝	21
25	6	440	60	69¼	21½	50	0⅝	21
25	8	323	67¼	73½	21½	56	7	22¾
30	8	300	67¼	73½	21½	56	7	22¾
40	8	300	81¼	90½	21¼	70¾	7	26¾
50	8	275	81¼	90½	24	70¾	7	26¾

PRACTICAL ENGINEER

PROPERTIES AND APPLICATIONS OF ELECTRICAL INSULATORS.

Name of Substance	Max. Working Temp. in Deg. F.	Min. Thickness Used—inch	Dielectric Strength in Volts Per Mil.	Name of Substance	Max. Working Temp. in Deg. F.	Min. Thickness Used—inch	Dielectric strength in Volts per Mil.
1 Enamel Film....	400	0.0015	550–600	9 Natural Mica....	700	0.005	400–700
2 Bakelite-Asbestos.	450	¼	200	10 Built up Mica....	1000	0.005	400–600
3 Asbestos-Paper....	500	1/32	100	11 Mica-Paper	1000	0.004	200–300
4 Asbestos-Tape (Deltatape)....	500	0.010	250	12 Asbestos-Fibre....	1000	0.035	100–180
5 Vulcabeston...	500	1/32	130	13 Glazed-Porcelain...	1500	⅛	200–800
6 Sternoid....	600	⅛	135	14 Electrobestos....	1800	¼	50
7 Condensite.	600	¼	75	15 Hemit B...	2000	⅛	30
8 Gummon..	700	1/32		16 Soapstone...	2000	1/32	75–250
				17 Lava.....	2000	⅛	
				18 Fire-Clay...	2000	¼	
				19 Alundum...	2000	⅛	

APPLICATION AND PROPERTIES OF SUBSTANCE

1. Applied for coating bare electrical conductors. Moisture proof, hard, tough, elastic, should not come in contact with alcohol, shellac, turpentine, vegetable oils, etc., insoluble in mineral oil.

2. Applied in moulded form. Moisture proof, hard, strong, not affected by acids, oils, alkalis, does not warp.

3. Applied in sheets for covering metal bodies. Soft, flexible, little mechanical strength, absorbs moisture easily and therefore can be used only in dry places. The commercial product often contains iron and other impurities, reducing the dielectric strength to almost nothing.

4. Applied for covering bare electrical conductors. Soft, flexible, strong, moisture proof.

(OVER)

PRACTICAL ENGINEER

THERMAL CONDUCTORS

Name of Substance	Thermal Conductivity B.t.u. per hr. per sq. in., 1 in. thick, per deg. F.	Specific Heat	Specific Heat Watt-sec. per ounce per deg. F.
Silver.....	2.20	0.0559	3.656
Copper.....	1.443	0.0899	5.923
Aluminum.....	0.691	0.202	16.600
Zinc.....	0.608	0.0935	6.150
Yellow Brass.....	0.411	0.093	6.125
Iron.....	0.335	0.1249	8.225
Soft Steel.....	0.223	0.108	7.110
Graphite, solid.....	0.0503	0.30	19.79
Carbon, solid.....	0.0299	0.2–0.3	13.18–19.78
Water.....	0.00242	1.0	65.93
Air, constant press....	0.001158	0.237	15.62

FUSE METALS AND ALLOYS

Tin-Lead Alloy.						Other Metals.			
Rated Carrying C'p'city in Amp.	Fusing Current in Amp.	Length of Fuse in Ins.	Diam. of Wire in Mils.	Section of Ribbon in Inches.	Fusing Current in Amperes.	Diameter of Wire in Mills.			
						Alum'm.	Copper.	Plat'm.
⅛	½	1	2.5		0.164			1.0
¼	¾	1	4.5		0.300			1.5
½	1½	1	10		0.463			2.0
¾	2¾	1	13		0.647			2.5
1	3	1¼	16		0.850			3.0
2	5	1½	25		1	2.6	2.1	3.3
4	9	1¾	35		2	3.4	4.1	5.3
6	12	2	42		3	5.4	4.4	7.0
8	15	2	49		4	6.5	5.3	8.4
10	17	2¼	55		5	7.6	6.3	9.8
15	24	2¼	68		10	12.0	9.8	15.5
20	30	2½	82		15	15.8	12.9	20.3
25	37	2¾	94		20	19.1	15.6	24.6
30	43	2¾	103		25	22.2	18.1	28.6
40	56	2¾	122	0.360x0.047	30	25.0	20.5	32.3
50	69	3	137	0.440x0.047	40	30.3	24.8	39.1
60	81	3¼	158	0.440x0.094	50	35.2	28.8	45.4
80	106	3½	180	0.375x0.078	60	39.7	32.5	51.3
100	129	4	226	0.440x0.094	80	48.1	39.4	62.1
150	187	4½		0.570x0.094	100	55.8	45.7	72.0
200	243	4¾		0.875x0.094	150	73.0	59.8	
250	298	4¾		1.000x0.110	200	88.6	72.5	
300	351	5		1.000x0.150	250	102.8	84.1	
400	450	5¼		1.000x0.200	300	116.1	95.0	
500	550	6		1.250x0.200				
600	675	6½		1.500x0.200				

THERMAL INSULATORS

Substance	Therm. Cond. in Watts per hr. per sq. in., 1 in. Thick, for 1 Deg. F.	Substance	Therm. Cond. in Watts per hr. per sq. in., 1 in. Thick, for 1 Deg. F.
Cotton, pressed	0.684	Oak	12.74
Cotton, wool	0.900	Cork	15.23
Lava	1.69	Sand	21.4
Felt	1.835	Water	25.5
Fir, across grain	1.903	Plaster of Paris	27.6
Sawdust	2.555	Glass	31.8
Wood Ashes	3.600	Cement	34.55
Fir, along grain	6.380	White Marble	36.00
Infusorial earth	8.075	Asbestos Millboard	64.50
Paper	8.50	Slate across cleavage	76.3
Carbon	8.60	Fire brick	89.3
Magnesia	9.80	Slate along cleavage	137.8
Pine	9.97	Magnesia brick	151.
Carborundum	10.57	Carbon brick	491.
Air	12.05	Graphite brick	531.
Mica	12.05		

—THE ELECTRIC JOURNAL.

DIMENSIONS OF SMALL VERTICAL GENERATING UNITS

K. W.	No. of Poles	Size of Engine	Steam Pressure	Rev. per Minute	Dia. Pipes		Crosshead Pin		Crank Pin		Diameter Shaft	Main Bearing		End Bearing		Net Weight Lbs.
					Steam	Ex-haust	Diam.	L'gth	Diam.	L'gth		Diam.	L'gth	Diam.	L'gth	
2½	4	3½x3½	90	625	1	1¼	1	1¾	1⅝	1¾	1⅝	1⅝	3⅜	1	2⅛	625
3½	4	4½x4	90	525	1¼	1½	1¼	2	1⅝	2	1⅝	1⅝	5	1¼	3¼	995
5	4	4½x4	90	650	1¼	1½	1¼	2	1⅞	2	1⅞	1⅞	5	1¼	3¼	985
6	4	6x5	90	400	1½	2	1¾	2	1⅝	2½	1⅝	1⅝	6	1⅝	4½	1845
7½	4	6x5	90	500	1½	2	1¾	2	1⅝	2½	1⅝	1⅝	6	1⅝	4½	1825
8	6	7x6	90	375	2	2½	1¾	2½	2¾	3	2¼	2¼	6	2½	5¼	2350
10	6	7x6	90	450	2	2½	1¾	2½	2¾	3	2¼	2¼	6	2½	5¼	2365
10	6	7x6	90	350	2	2½	1¾	2½	2¾	3	2¾	2¼	6	2½	5¼	2725
12½	6	7x6	90	425	2	2½	1¾	2½	2¾	3	2¾	2¼	6	2½	5¼	2735
15	6	8x7	90	325	2½	3	2¾	4	3	4	3	3	6	2½	5⅜	3401
17½	6	8x7	90	400	2½	3	2¾	4	3	4	3	3	6	2½	5⅜	3415
20	6	8x8	90	325	3	3½	2¾	4	3	4	3¼	3¼	6	2½	5⅛	54.0
25	6	8x8	90	400	3	3½	2¾	4	3	4	3¼	3¼	6	2½	5⅛	5450
25	8	10x8	90	325	3	3½	3	4½	4	4½	3½	3½	8¾	3	6	6800
30	8	10x9	90	300	3	3½	3	4½	4	4½	3½	3½	8¾	3	6	7000
40	8	10x10	90	300	3	3½	3½	6	5	6	4½	4½	10	4	8	9650
50	8	12x10	90	275	3	3½	3½	6	5	6	4½	4½	10	4	8	10750

All dimensions are in inches.

5. Applied in sheet and moulded form. Hard, strong, not affected by acids, oils, alkalis, does not warp, softens above 500 deg. F., but does not carbonize, can be highly finished.

6. Applied in moulded form. Hard, strong, moisture proof, non-combustible, can be highly finished.

7. Applied in moulded form. Hard, strong, insoluble in oils, moisture proof, finished in black.

8. Applied in moulded form. Hard, but not very strong, moisture proof, can be highly finished.

9. Applied in sheet form. Moisture proof, hard, strong, insoluble in oils and most acids, does not warp or shrink, non-combustible.

10. Applied in sheet and moulded form. Only built up mica made with a binder which will not disturb the insulating qualities of the mica, when heated up, can be used. The binder in the products known as mica plate, micanite, flexible mica, megomit, megotalc ordinarily does not fulfill these requirements. Flexible, strong, does not warp or shrink, according to binder absorbs moisture or is non-absorptive.

11. Applied form of tape for covering bare electrical conductors. After the conductor is wrapped, the paper must be burned off, leaving the pure mica as insulator. Means have to be provided to hold the mica in place. Excellent method to insulate lead wires, when space is limited.

12. Applied in form of woven cloth and sleeving for covering flexible, portable heaters and bare electrical conductors. Soft, flexible, strong, absorbs moisture easily and therefore can only be used in dry places, melts with about 2300 deg. F. The commercial product often contains iron and other impurities, reducing the dielectric strength to almost nothing.

13. Applied in moulded form. Hard, strong, not affected by acids, oils, alkalis, moisture proof, can be highly finished. Becomes a fair conductor at high temperatures, so that it cannot be used for furnace work, although it requires about 2750 deg. F. to fuse it.

14. Applied in moulded form. Hard, but not very strong, not affected by acids, oils or alkalis, but absorbs moisture.

15. Applied in sheet or moulded form, the latter only, if the shapes are not complicated. Hard, but not very strong, not affected by acids, oils or alkalis, but absorbs moisture. Can be machined, drilled, sawed and polished.

16. Applied in slabs. Soft, not very strong, not affected by acids, oils or alkalis, can be machined, drilled and sawed, absorbs moisture.

17. Can be machined as accurately as brass in natural state and before being baked. Hard, moisture proof, not affected by acids, oils or alkalis.

18. Applied in semi-liquid form and baked, after the bare electrical conductors are embedded. Becomes a fair conductor at high temperatures. Not affected by acids, oils, alkalis.

19. Applied in moulded form for supporting bare electrical conductors.

The Electric Journal.

SAMPLE "B"—PURIFIED OIL

Color: Very dark red, opaque. Flash point: 410 deg. F. (open cup). Burning point: 440 deg. F. (open cup). Specific gravity at 60 deg. F. water as 1 = 0.903. Viscosity (with Olsen viscosimeter). Water as 1 at 60 deg. F. Time, 27.9 sec. for 100 cc.

Temperature F.	Time for 100 cc. sec.	Relative Viscosity
68.0	138.0	4.94
69.0	134.0	4.80
70.0	130.2	4.66
103.0	60.4	2.16
114.0	50.6	1.81
130.0	45.2	1.62
152.0	39.0	1.40
147.5	40.2	1.44
218.0	33.2	1.19

The viscosity readings have been plotted in the form of a curve, shown in Fig. 3.

The above data was furnished by the engineering department of The Richardson-Phenix Co., Milwaukee, Wis.

Water Treatment Outside the Boiler

IN order to render water suitable for boiler feed purposes, it must be freed from foreign matter, both soluble and insoluble. The insoluble can be readily removed by straining or filtering, and bicarbonates of magnesium and calcium, which are held in solution by carbon dioxide in the water, may be separated by heating alone. Other substances, such as make up the permanent hardness and are not precipitated by heat alone, require the addition of chemicals, and if by such addition and heating the foreign matter is thrown down in the boiler, scale is formed which may be soft or hard, according to its makeup and the conditions under which it is formed.

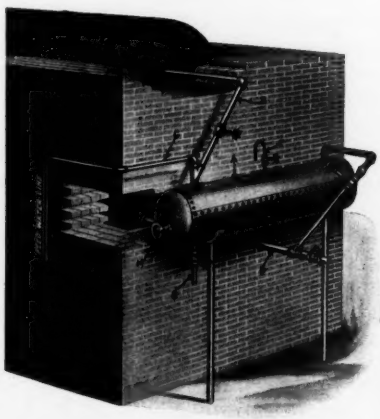


FIG. 1. THE BAYER FEED-WATER PURIFIER ON A HORIZONTAL RETURN-TUBULAR BOILER

In the method here shown, the Bayer feed-water purifier operates to cause the precipitation of foreign matter outside the boiler, by a method of treatment and sedimentation. The arrangement of the apparatus is shown in Fig. 1. A circulating pipe, B, carries hot water to the settling tank, A, and the line, D, returns water to the boiler, usually through the blowoff, thus completing the circulating system. Feed water comes through the pipe, C, and is turned towards the left-hand head of the tank by an internal elbow. The ejector action of this water tends also to draw water from the boiler through the pipe, B, thus adding to the circulation in the purifying tank.

By thus mixing the feed water with water from the boiler, the water in the tank is heated practically to boiler temperature, causing the carbonates to be precipitated. Where it is necessary to use a chemical reagent, this is mixed with the feed water before it enters the purifier, so that all precipitation takes place in the tank, A, through which the flow is relatively very slow. Sediment deposited in the tank, A, is blown out through the valve and pipe, E, and the scraper, of which the handle, M, projects through the left-hand head of the tank, is used to pull the sediment towards the blowoff valve. Because of the high temperature at which the action in the purifier takes place, the action of any chemical reagent is very rapid, being some 500 times more rapid than in cold water. If any dissolved gases are liberated in the tank, they may be drawn off through the pipe, F, which serves also for drawing off samples of the water to make tests for proper proportion of chemicals.

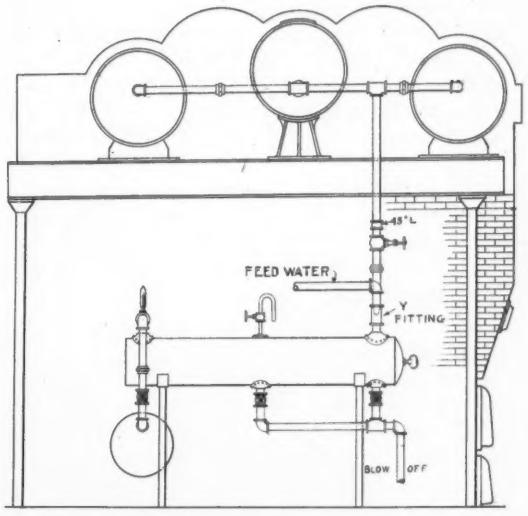


FIG. 2. CONNECTIONS OF PURIFIER TO A STIRLING WATER-TUBE BOILER

The Bayer purifier is made under the patents of James A. Ray, and was formerly marketed by the Ray Steam Specialty Co. The manufacturers claim that with it in use, a boiler need never be blown off, and that the tubes are kept free from scale, so that turbining is not required. While Fig. 1 shows the purifier attached to a return-tubular boiler, it is applicable, by proper connections, to other types, as shown in Fig. 2. It is made by the Bayer Steam Soot Blower Co., of St. Louis, Mo.

Book Review

MECHANICAL WORLD ELECTRICAL POCKETBOOK for 1914, which is handled in the United States by Norman & Remington, 308 No. Charles St., Baltimore, and priced at 25 cents, is a collection of electrical engineering notes, rules, tables and data, in cloth binding, which is surprisingly good value for the small amount asked. It deals with electrical units of voltage, current and resistance, with fundamentals of batteries, with the magnetic circuit and magnetic materials; then goes on to the windings of dynamos and motors, and their operation, and to the mathematics of alternating-current systems, although these are kept in simple form. Principles of Motor Generators, Transformers, the Power Required to Drive Different Kinds of Machinery, the Operation of Boosters, Operation of Storage Batteries, Calculation of Wiring Circuits, a description of Circuit Breakers and Measuring Instruments, discussion of Different Methods of Lighting and Different Kinds of Lamps, the Fundamentals of Telephones, Electric Welding and Electric Cranes, are some of the more important headings. Much of the data is in regard to English machinery, but the tables and general rules are also applicable to American practice, and the book is well worth possessing.

THE MORTAR-MAKING QUALITIES of Illinois Sands, by C. C. Wiley of the Department of Civil Engineering of the University of Illinois, has just been issued as Bulletin No. 70 by the Engineering Experiment Station of that University.

This bulletin discusses the effect of the characteristics of the sand upon the quality of mortar. The results of a series of tests on 32 representative Illinois sands are given in tabular form and discussed. A classification of different sands is then proposed and specifications for each class suggested.

Copies of Bulletin No. 70 may be obtained upon application to C. R. Richards, Acting Director of the Engineering Experiment Station, University of Illinois, Urbana, Ill.

A DIRECTORY of the names of South American importers and merchants, made by American consular officers, is now completed and is available in bound form, at $1.00 a copy, from the Bureau of Foreign and Domestic Commerce, Washington, D. C.

FARM MOTORS, by Andrey A. Potter, 260 pages, 5½ by 7 in., with full illustrations, in cloth binding; New York, 1913, price $1.50 net.

An idea of the range of subjects covered may be gained from the chapter headings, which are as follows: Farm Motors in General, Fundamental Principles and Definitions, Steam, Fuel and Combustion, Steam Boilers and Auxiliaries, Stationary Steam Engines, Gas and Oil Engines, Traction Engines and Automobiles, Water Motors, Wind Mills, Electric Motors, Dynamos and Batteries, Mechanical Transmission of Power. The book is aimed to assist those who have to do with machinery on the farm, in understanding and operating such machinery, and for this purpose is well planned, giving practical hints on operation without going into unnecessary mathematics or straying into matters of design. It is somewhat startling to find water-tube boilers, feed water heaters and Corliss engines classed as farm motors, but using the term in the larger sense, and considering the plantations in the South and ranches in the West where sugar mills, cotton gins and machine shops are in order, as well as the fact that such a book is likely to be used by many who are not working on the farm, the inclusion is justified.

This is designed as a textbook for agricultural schools, and under each type of motor considers the principles underlying the construction; the principal parts of the motor; the auxiliary parts; uses to which the particular type of motor is adapted; selection, erection and management.

GAS POWER, by C. F. Hirshfeld and T. C. Ulbricht, 5 by 7 in., 210 pages, fully illustrated and indexed, in cloth binding, New York, 1913, price, $1.25.

This book, one of the Wiley technical series, is a simple and non-mathematical treatment of the subject, adapted for the needs of students in the higher classes of manual training schools, and to give the reader such knowledge as will enable him to appreciate the present commercial conditions in this branch of engineering. It deals, first, with the heat problem in general; then takes up the question of fuels and their availability for gas engines; then a comparison of the external and internal combustion principles, and a chapter on historical development. From this point, the discussion is more particularly in regard to the detail points of gas power apparatus, including 4 and 2-stroke operation, methods of cooling the cylinder, how the engines are governed and how the governors operate, ignition systems, carbureting and carburetors, a classification of modern engines, and a discussion of modern types for gas, gasoline and oil. The question of gas producers is given a chapter, also the matter of gas engine auxiliaries, such as starting devices and mufflers, and finally there are discussed the rating of gas engines, methods of testing, the performance of American engines in practice, and hints on practical operation. As stated in the first sentence, the book is elementary in character, and therefore does not give much of technical value to the expert who has operated gas engines, but it is a good introductory book to the subject, and gives a clear understanding of the principles on which the different parts of a gas power system work, and sufficient of the details to form a good foundation for further reading and study.

AMERICAN ELECTRICIAN'S HANDBOOK, by Terrell Croft; 700 pages, fully illustrated, 4 by 7 in., in full leather binding, New York, 1913, price $3.

There has long been a field for a handbook suited for men who have to install and operate electrical machinery and apparatus. A number of good books have been available for electrical engineers who have to do with mathematical computations and design, and with the more abstruse problems and testing, but the present book is aimed to give the fundamentals, a plain statement of principles and theories, and to cover all practical phases, giving rules and solving specific problems to which these rules apply, and to make every detail clear by careful statement and simple illustrations.

For a dozen years Mr. Croft has been engaged in collecting a personal file of loose leaf notes on practical electrical subjects, and has had the good sense to abstract largely from other sources where he found material suited to his hand. Much of the material he has written himself, but has not felt obliged to confine himself to his own writing, where he found material by other authors which suited his purpose exactly.

Sections are: I. Fundamentals, including the principles of electricity and magnetic units, Measuring and Testing, Circuits and Electrical Distribution, Batteries, and the Calculation of Circuits. Section II takes up Generators and Motors, the Principles, Characteristics and Troubles of such machinery, Application of Electric Motors, and the Installation of Motors and Generators. Section III is on Outside Distribution, including poles, lines, underground conduits, and the design of distribution systems. Section IV, on Interior Wiring, takes up Fittings and Materials, Methods of Wiring, Wiring Costs and Electric Heating Devices. Section V, on Transformers, treats of connection for single phase, 2-phase, and 3-phase, and for special purposes, also the Construction of Transformers of special forms, and Methods of Installation. Section VI, on Illumination, takes up the Principles and Units, the Use of Arc and Mercury Vapor Lamps, and different arrangements for Interior and Exterior Illumination.

The book is conveniently arranged, fully indexed, provided with illustrations that exactly fit the text, and that give real practical information, and is well worth owning and studying.

Catalog Notes

HOW A CENTRAL STATION Can Overcome Its Belt Troubles is the name of a pamphlet just published by the Cling-Surface Co., Buffalo, N. Y. In its pages the slack belt is strongly advocated, pictures of various kinds of drives are shown and technical information is given descriptive of each drive. Copies will be mailed free on request.

AN INTERESTING BULLETIN from the University of Illinois, while not in the line of power plant work, indicates the excellent service which is being performed by the University in its various departments. This one has to do with the testing of seed corn and clover seed, and gives complete directions for making such tests, how to prepare for them, how to conduct the tests and make records, and how to determine whether the seed is satisfactory or not. The work is along the line of helpfulness to the community, for which the work of the University is noted.

GERMANY NOW USES between 40,000,000 and 50,000,000 gal. of denatured alcohol a year, of which over 30,000,000 gal. are sold to the general public for burning purposes. The importance of this fuel in Germany may be appreciated when it is considered that France uses about 18,000,000 gal., the United States about 10,000,000 gal., and the United Kingdom only 4,000,000 gal., according to a monograph by Charles A. Crampton, commercial agent of the Department of Commerce, recently issued by the Bureau of Foreign and Domestic Commerce. Denatured alcohol is not only gaining in favor for general burning purposes, but a determined effort is being made to find a way of using it as a motor fuel in place of the high-priced gasoline. All the recent developments are dealt with in the new monograph, which is entitled "Production and Use of Denatured Alcohol in Principal Countries" (Special Agents Series No. 77). Copies at 5 cents each may be had from the Superintendent of Documents, Government Printing Office, Washington, D. C.

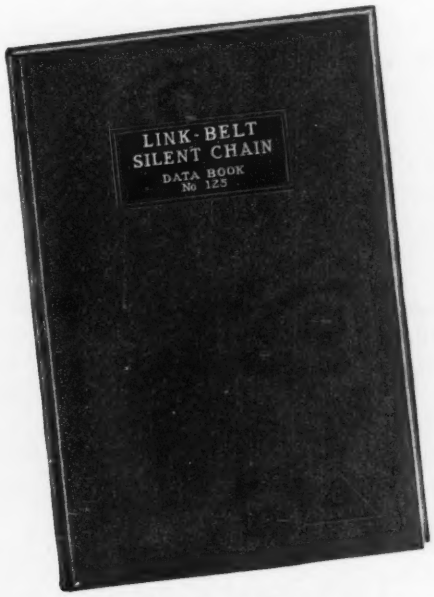
THE OHIO BRASS CO., Mansfield, Ohio, has issued a new valve catalog, No. 50, listing for the first time, its J. D. globe, angle and check valves, standard and special patterns.

A NEW FOLDER relating to Jenkins Bros. automatic equalizing stop and check valves, globe or angle, extra heavy pattern, was lately received from Jenkins Bros., 80 White St., New York.

FROM CRANE CO., 836 S. Michigan Ave., Chicago, we have received Circular No. 78A describing and illustrating Crane unions and union fittings.

CADMAN'S GATO VALVE and other specialties manufactured by A. W. Cadman Mfg. Co., Pittsburgh, Pa., are described and illustrated in the company's 1914 catalog, No. 5.

THROUGH ERROR the accompanying cut of the New Link-Belt Book was omitted from the April 1 issue, which gave a review of the book on page 427. Owing



to the value of this book to engineers as a reference on silent chain drives it should be on the shelf of every engineer who transmits power.

THE GRATON & KNIGHT Mfg. Co., Worcester, Mass., has just issued its latest catalog. This supersedes all previous editions and describes various kinds of leather belting and associated products, also giving mechanical rules, tables and suggestions for the proper care of belting.

PRACTICAL ENGINEER

Trade-mark, Reg. U. S. Pat. Off.

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Position Wanted

POSITION WANTED—As assistant engineer, oiler or wiper, in some power plant. Am a graduate of I. C. S. Have had a few years' experience and can furnish good reference. Will accept small salary to start, with chances of increase as I advance. Address Guy List, McCordsville, Ind. 4-15-1

POSITION WANTED—By Electrical and Mechanical Engineer as Superintendent or Chief Engineer of suction gas or oil engine light and power plant. Broad experience. Power plant erection and maintenance. Age 30. Married. Speaks Spanish. W. M. Gardner, Shreve, O. 4-15-1

POSITION WANTED—As second engineer in a gas or steam plant or as first engineer of a small plant. Have had some experience. Address G. A. Kirby, Midland City, Ill. 4-15-1

POSITION WANTED—By Gas Engineer with 13 months' experience on producer gas engine and 4 years on smaller engines. I. C. S. graduate. Age, 23. Excellent references. Address Box 53, Wyalusing, Pa. 4-15-1

POSITION WANTED—As Stationary or Locomotive Engineer with 5 years' experience; wants position with some good concern. Can furnish reference as to ability and character. Address Box 57, Rainier, Wash. 4-15-1

POSITION WANTED—By Stationary Engineer with 10 years' experience with Saw Mill and Dunke engines. Have Washington license. Address J. Wilkin, Portland, Ore. 4-15-1

POSITION WANTED—As Engineer in small town. Have had 12 years' steam and electrical experience; also practical machinist. Address Box 339, Practical Engineer. 4-15-1

POSITION WANTED—By millwright and steamfitter. Experienced in both construction and repair work in both lines. Am open for engagement May 1st. I solicit correspondence with firms having positions open. Address H. Leland, Box 382, Cedar Rapids, Ia. 4-15-1

POSITION WANTED—In large plant or manufacturing company by man with 4 years' practical experience in light and power plant; understands line work and wiring. Have A. S. of C. course. Competent to handle small plant. Address Box 342, Practical Engineer. 4-15-1

POSITION WANTED—By engineer familiar with power house and refrigerating plant. 18 years' experience. Can furnish good reference. Address W. Barton, 416 High St., Elizabeth, N. J. 4-15-1

WANTED—To correspond with reliable concern desiring the services of a Master Mechanic. Have been located with one of the largest manufacturing firms in the country for years in capacity of erecting engineer. Address Box 343, Practical Engineer. 4-15-1

Wanted

ENGINEERS AND FIREMEN wanted in every city in New England to organize locals of the Brotherhood of Power Workers, an organization composed of Engineers, Firemen and other power workers; incorporated under Massachusetts laws; aims to raise efficiency of members and to get results due higher efficiency; has employment bureau; pays sick, accident and death benefits. Write for particulars. Secretary, B. P. W., 89 Hall St., Springfield, Mass. 4-15-1

IF YOU RECOGNIZE the value of approved specialties in an engine and boiler room as a means of higher efficiency; if you believe in this sort of thing to the extent that you think you could sell a well-known boiler specialty in your territory for an old-established manufacturer in the power-plant field, write and tell us all about yourself. On receipt of your letter we will outline our proposition in full. Address Box 324, Practical Engineer. tf.

WANTED—A small ice-making and refrigerating plant with a daily capacity of about 10 to 15 tons, is wanted by a subscriber. A second-hand plant preferred. Give full particulars. Address Box 341, Practical Engineer. tf.

WANTED—Every local Engineers' Association to have an assortment of valuable power-plant books—Secretary, write at once, for full particulars. Address Dept. C, Practical Engineer, Chicago.

IF YOU ARE a night engineer, spend a few hours each day taking subscription for Practical Engineer. You will be paid well. Write Subscription Dept. They will start you in at once.

WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

Help Wanted

WANTED—A competent, reliable and experienced chief engineer to take charge of power plant for saw mill and electric driven planer in South. Must be first class electrician and Corliss Engineer. Give reference in first letter. Address Box 344, Practical Engineer. 4-15-2

MUST HAVE SALESMEN—Wanted at once, hustlers in every city, to take orders for ZINCO SOOT DESTROYER. Quick, easy seller. Engineers are waiting. Fine proposition. Address New York Supply Exchange, Detroit, Mich. 4-1-2

WANTED—An additional subscription solicitor wanted to cover towns in the State of Oklahoma. Excellent chance to earn extra money. Write to Subscription Department. tf.

For Sale

FOR SALE—75-kw. Westinghouse, revolving field, late type, 60-cycle alternator, direct connected Harrisburg engine, with exciter, practically new (at present 2-phase, 440 volts, but will change for 3-phase and 220 volts, free of cost), $1250 f.o.b. Cleveland, Ohio. Also about 90 a.c. motors. Duzets & Son, 50 Church St., New York. Send for complete "Bargain List." tf.

USE AN AIR-FRICTION with new 1914 improvements. Increases power and economy of motor one-half. Absolutely impossible to choke or load. Uses distillate gasoline or half kerosene with finest results. Starts easy in coldest weather. We fit all motors, guaranteeing definite results or refund money. Exclusive county rights. Liberal exchange on other carburetors. The Air-Friction Carburetor Co., Dayton, Ohio. 2-15-6

FOR SALE—2 Buckeye steam engines at bargain prices. 1 12x21-in., 85-hp., 185 r.p.m., 85-lb. steam pressure, flywheel 6 ft. diameter, 22-in. face. 1 11x18-in., 70-hp., 200-r.p.m., 85-lb. steam pressure; flywheel 4 ft. diameter, 14-in. face. Changed to motor drive. Must move at once. Write today. The W. H. Mullins Co., Dept. A., Salem, Ohio. 4-15-6

DIRECT CONNECTED UNITS—Two 75-kw. Crocker-Wheeler, 250-volt generators, direct connected to 14x14 Harrisburg Fleming, side-crank engines, with switchboards. (Also Balancer Set), each, $1200. Duzets & Son, 50 Church St., New York. Send for latest stock list of direct-current, 230-volt motors. Prices right. tf.

FOR SALE—Two 250-kw. Rotary Converters, type E. C., form E, class 6-250-500, 500 r.p.m., 600 volts, d.c.; d.c. amperes 416; a.c. end, 25 cycles, 3 phase, 360 volts. These machines are in A-1 condition and can be delivered at once. Price, $1,400 each, f.o.b. cars (Penna. delivery). F. H. Herring, Inc., 30 Church St., New York. 2-15-6

FOR SALE—At a Bargain. New 5x6, 4-cylinder governor-controlled engine, fully equipped with carburetor magneto. Will sell for much less than cost. Fred Hanson, 570 Prior Ave., St. Paul, Minn. 4-15-2

GAS ENGINE for sale, 60-hp., Elyria tandem, with air pump and tank, water pump, magneto, and everything complete in good condition. Taunton Planing Mill Co., Taunton, Mass. 4-1-2

FOR SALE—One 95-hp., 3-cylinder Westinghouse producer gas engine and complete equipment for operating suction type. Constant use one year. Practically new. Address Box 345, Practical Engineer. 4-15-6

TRAVELING CRANE—Wooden—For Sale Cheap. 15-ton capacity, 65-ft. span, suited for either motor or wire rope drive. Write Box 346, Practical Engineer. 4-15-6

OUR MODERN BLUE-PRINT CHART method of electrical wiring. Write for information. Electrical Wiring Diagram Co., Box F173, Altoona, Pa. 11-15-12

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PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and book of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

PATENTS—C. L. Parker, Attorney-at-Law and Solicitor of Patents. Patents secured promptly and with special regard to the legal protection of the invention. Handbook for inventors sent upon request. 186 McGill Bldg., Washington, D. C. tf.

PATENTS THAT PROTECT AND PAY. Advice and books free. Highest references. Best results. Promptness assured. Send sketch or model for free search. Watson E. Coleman, Patent Lawyer, 624 F St., Washington, D. C. tf.

PATENTS—H. W. T. Jenner, Patent Attorney and Mechanical Expert, 606 F St., Washington, D. C. Established 1883. I make a free examination and report if a patent can be had and the exact cost. Send for full information. tf.

PATENT WHAT YOU INVENT. It may be valuable. Write me. No attorney's fee until patent is allowed. Estab. 1882. "Inventor's Guide" FREE. Franklin H. Hough, 357 Loan & Trust Bldg., Washington, D. C. 4-1-2

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Educational and Instruction

ENGINEERS' POCKET MANUAL, 175 pages edited by University of Tennessee, will be mailed every subscriber sending in NEW subscription (not your own) to Practical Engineer. Gilt edges; bound in leather.

Technical Books

BOOKS ABOUT ELEVATORS—Best published. W. A. Morse, 19 Union Place, Yonkers, N. Y. 2-15-6

Miscellaneous

ENGINEERS—DO YOU WANT to utilize your exhaust steam for heating or drying purposes, without back pressure on your engine? If so, address Monash Engineering Co., 1413 W. Jackson Blvd., Chicago, Ill. tf.

MAKE MONEY on the side. Here's your chance to work out some money for yourself. Get subscriptions for Practical Engineer. It pays well. Just drop a line to the Subscription Dept. They will tell you. tf.

Sparks From The Advertising Pages

Out in New York is a weekly periodical, "Printer's Ink," which circulates among advertising men. To a great extent, its pages are the gathering place of the expressed ideas of the men actively engaged in the promotion of advertising.

It is interesting, therefore, to find in its pages, an utterance of the Curtis Publishing Company (publishers of the Ladies Home Journal and the Saturday Evening Post), emphasizing the idea that the price of publicity is consistency; that quality *must* be maintained on advertised goods.

Their argument, although addressed to advertising men, is so conclusive and so interesting that it can be well addressed to buyers of power-plant equipment, so we quote:

"The man who advertises, commits himself. He steps up on a high place and says: 'Here am I. This is my product. I solicit your careful consideration.'

"And there he and his goods must stay. There is one thing that advertising cannot do. It cannot maintain the popularity of an article that has proved itself unworthy of popularity.

"The obscure manufacturer may tamper with the quality of his goods as his ethics dictate. But the man with a nation-wide reputation cannot, for one minute, detract from his quality without skillful eyes detecting it and eager mouths bruiting it about the market place.

"There have been manufacturers who, knowing the power of advertising to establish their line in public favor, have set out with an 'introductory' quality which they did not intend to maintain. And they had forgotten to take into consideration the vested right of the consumer to stop buying an article when it becomes unsatisfactory."

* * *

To this we can only add an excerpt from our January 15th "Sparks Page":

"The best reason why you should buy the machinery and other power-plant equipment advertised in Practical Engineer is the very fact ***that*** *it is advertised."*